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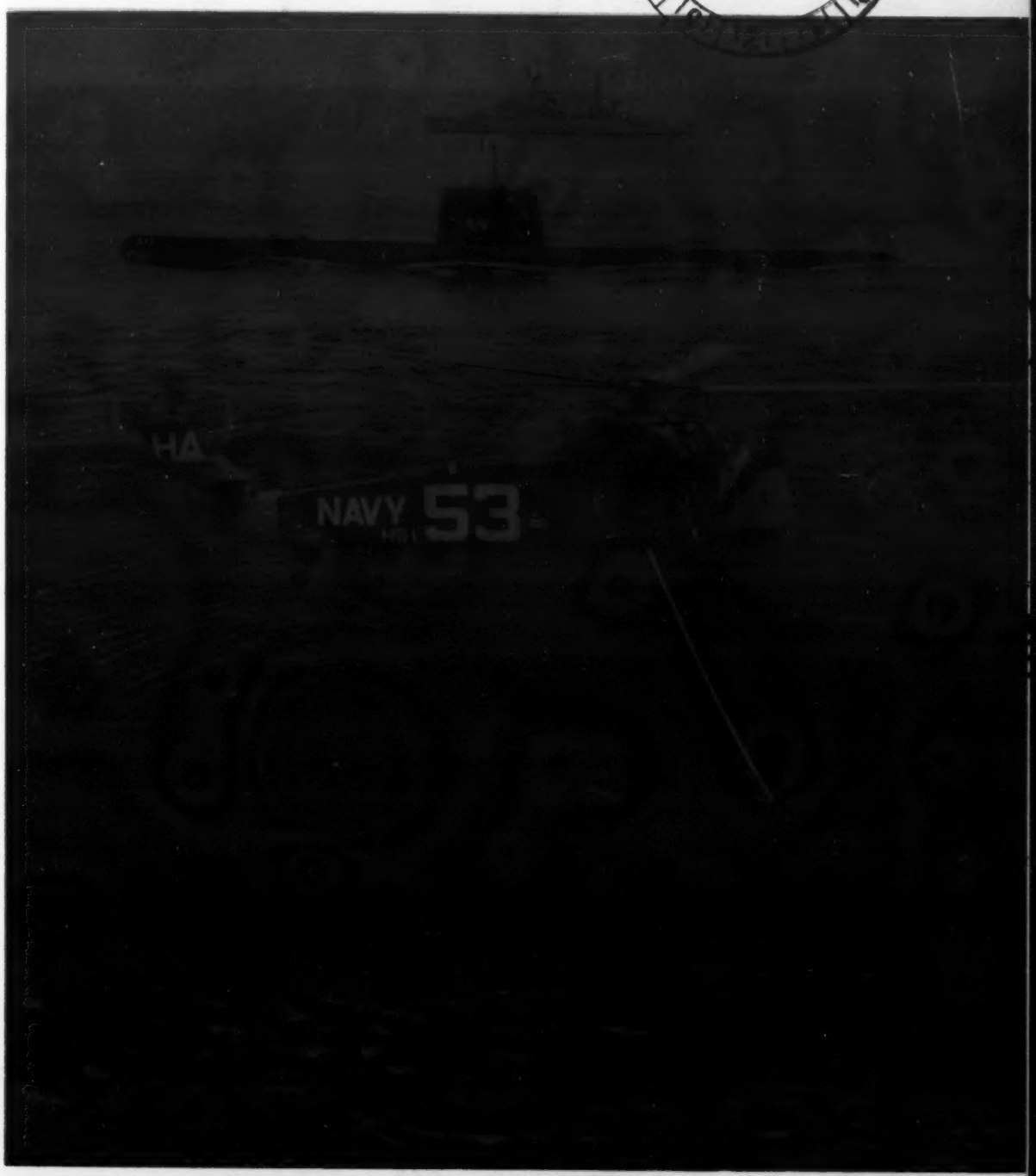

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MILITARY SYSTEMS DESIGN

VOLUME 4, NUMBER 4
JULY-AUGUST 1960

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COVER: A HS-4 helicopter operates its "dunking sonar" while the snorkel submarine DARTER (SS-576) and the radar picket escort destroyer CALCATERRA (DER-390) carry out ASW exercises. *U.S. Navy Photo.*

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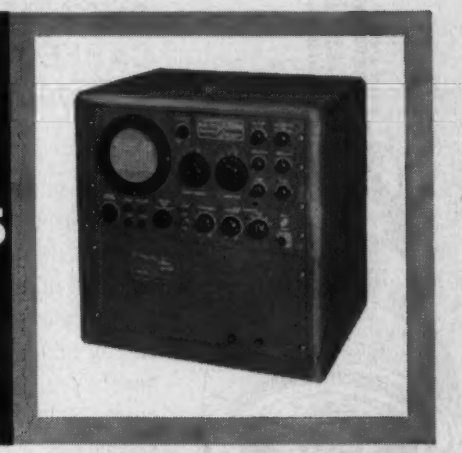

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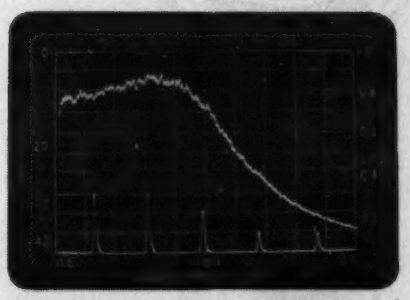

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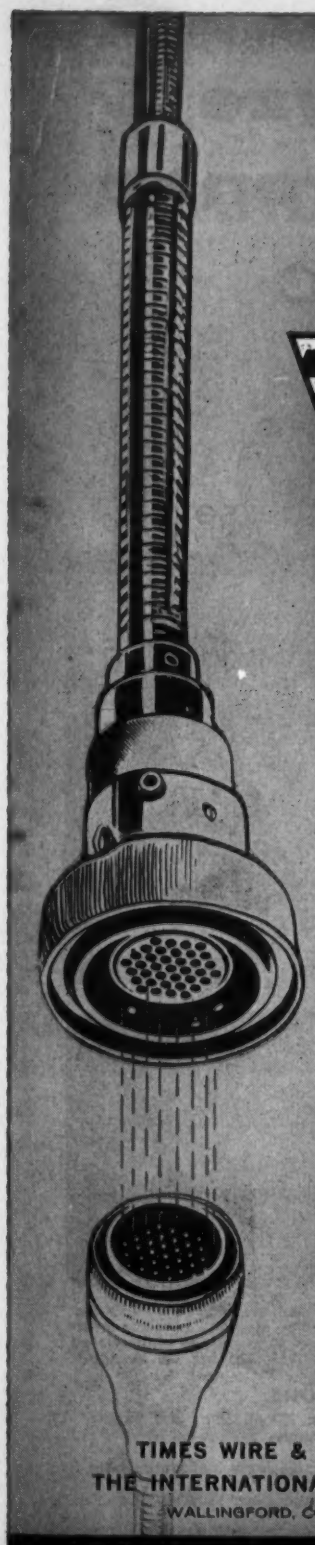

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MSD editorial

NEEDED—A Systems-Designed Fleet for the Nuclear Age

NAVY GUIDED MISSILE TRAINING CENTER, Dam Neck, Va.—Discussions with officers attending the training courses in Naval Missiles systems have proved to be as interesting as the sophisticated systems which they study here. Although only the previously publicized and general capabilities of the POLARIS and other operational missiles are mentioned in these talks one feels that the observations of such experienced Commanders and Captains on world developments and trends in weapons systems are based on a complete, not a partial, reading of the situation.

One opinion which finds expression is that the time is ripe for a thorough job in naval systems design.

After World War II the United States had not only a monopoly of the Atom Bomb but also possessed thousands of ships, tanks, and aircraft of modern design and equipment. Using newly-developed preservation techniques, those units not required by the peacetime forces were put into "Mothballs," from which many were quickly withdrawn for active duty during the Korean war.

Although the preservation of large numbers of deactivated ships and weapons made sense after World War II and again after the Korean Engagement, the relentless march of technology on many fronts is now making obsolete fundamental designs of hull and power plant as well as the major weapons carried by them. Even if equipped with the lastest in antisubmarine weapons, these slow ships will soon be unable to operate effectively with the new high-speed units and if war should come would be manned only with great cost in manpower in a desperate attempt to cope with the enemy submarine threat.

Problems which are uppermost in the thoughts of responsible Naval commanders include: Preponderant numbers of Russian submarines, of highly effective design; limited range of antisubmarine warfare detection methods, which demand greater numbers of ASW vessels, planes, blimps, or helicopters; large and increasing numbers of aging and obsolete U. S. Ships in commission and in preservation; increasing costs of conventional ship modernization and construction; increasing technical competence needed to maintain ships and weapons systems; and rapid turnover of trained technical personnel.

The foregoing poses the problem. In the words of one Navy captain, the present "Fleet Rehabilitation and Maintenance" (FRAM) and "Augmented Pay for Technical Personnel" programs are less than long term solutions.

USS GEORGE WASHINGTON (SSB(N)-598)—shown in cut-away model—recently announced successful full-scale tests of **POLARIS** missile, fired from vertical tubes amidships.

Recent research studies in water-based craft indicate that the rapid movement and wide dispersion needed by fleets in the nuclear age may be achieved by new type ships using hydrofoils, air reaction effects, or new underwater hulls to gain higher speed. Such high-speed units would be much smaller than the large carriers which were the backbone of the airplane-bomb weapons system of World War II; but would have antisubmarine, as well as nuclear missile, and personnel-carrying capabilities. Such ships might be manned by an unbelieveably small crew, due to the application of automatic computers and controls and to the use of automated communications.

Such a flexible, all-purpose fleet—capable of defense against large numbers of missile-carrying submarines; of providing easily hidden and highly mobile missile bases; and of carriers for landing forces and planes needed to assist our allies in "brush fire" type engagements anywhere on the globe—can be realized in less cost of dollars and time than many of the space programs now being accomplished but which still leave much of the Free World open to submarine-borne missile attacks.

One officer pointed out that a number of very capable system research and development teams in the missile and aircraft industries have recently suffered the cancellation of their government contracts and are now looking for new projects worthy of their capabilities and talents. If these efficient teams disband, their unique combination of abilities will be dispersed and in many cases these assets will be lost to the nation. Timely action could divert much of this knowhow in systems design into an area which the Navy could well use and which the Nation and the Free World desperately need! Within three to five years a modern under-water-surface-air integrated system utilizing the latest in solid-state technical devices engineered for the maximum in interchangeability and maintainability could be under construction.

So bold a step forward would be a resounding industrial and economic answer to Kruschev's "We will bury you" challenge. Granted, the Russians will not be idle during the next five years. However, such a move would at once checkmate their submarines, the most serious sea-based threat now posed against the Free World, and demonstrate the power of a free economy to develop and implement new ideas. If we are going to compete with the Soviets, let's lead the competition and let them worry about how to convince their people and the uncommitted world that their system is the best.

C. O. M.

WESCON 1960

The WESCON show for several years has occupied a position of growing importance to manufacturers and designers of Military Systems as well as to other sectors of the Electronics and associated industries. Timed to supply a mid-calendar exposition, complementing the March IRE show in New York, it is located on the West Coast to better service that rapidly growing center of Electronic and Systems Design. The WESCON show also has special interest for that portion of our industry which is peculiarly dependent on the Government expenditures that normally become available at the first of each fiscal year.

The products and developments which they will feature at the WESCON show are mentioned by many suppliers in their releases and advertisements in this issue of MILITARY SYSTEMS DESIGN. However, we make no attempt to provide an exhaustive catalog of exhibitors. This session is also expected to serve as a recruiting ground for the services of available designers and engineers, as usual. In one context or another, new solid-state computer techniques and the disciplines used in computer systems will constitute a major portion of the technical program at WESCON 1960. New micro-wave techniques, particularly those associated with missiles, space and telemetry, are also stressed.

WESCON 1960 comes at a crucial time in our political and industrial life. Both the Republican and Democratic standard bearers for the November presidential contest have been selected. We anticipate that—under the pressure of World events and awakened domestic public opinion—the new administration, regardless of the outcome of the balloting, will show an increased appreciation of national defense needs which will result in upward budgetary revisions in the months to come.

Such firming of program, particularly if accelerated by determined action by the current Congress before it adjourns, should help dispel the uncertainty and indecision which have plagued many sectors of our economy during the past two years.

If the Cuban-Communist axis is further consolidated in the near future, intensified activity in a number of defensive areas must logically follow. These might include sorely-needed expansion and modernization of antisubmarine forces; implementation of Civil Defense preachments, including the beginnings of a fall-out shelter construction program; missile production to fill the munitions allowances of our active Armed Forces units and intensified training of all Ready Reserve units of the Army, Navy and Air Force.

Vigorous and decisive action may yet be enough to influence the Communist bloc to use caution in attempting a Caribbean beachhead. If not, it will be more urgently needed as a start in the direction of the far greater effort with which we will then be faced. The shadow of great events to come will be present in the Los Angeles Sports Arena, August 23-26.

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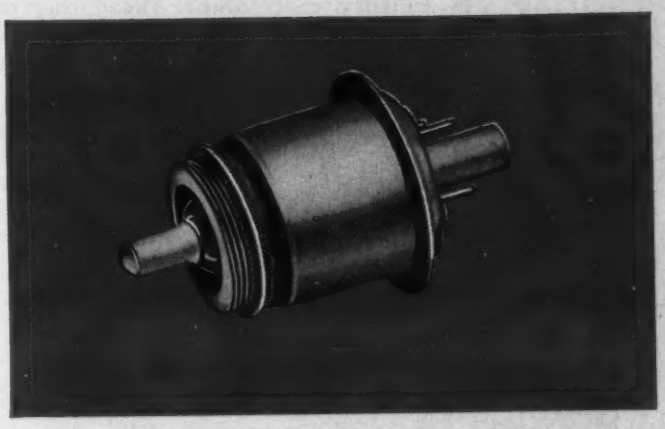

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TIMM Circuits -- A New Concept In Military El

Microminiaturization no longer is faced with a thermal barrier when "Thermionic Integrated Micro-Modules" (TIMM) are used in military electronics. These tiny metal and ceramic circuits, now in development, are under serious consideration by the services and many manufacturers of military electronic equipment as a new and promising approach to increased efficiency and reliability in ever-more-difficult environments. These rugged circuit modules perform the functions of tubes, resistors, capacitors and other components—with high tolerance to both steady-state and pulse radiation and to high temperature. Thus they are proving extremely important in advanced weapons concepts and for space probes and satellites.

Mr. Allen P. Haase (right), Development Engineering Manager, General Electric Receiving Tube Dept., Owensboro, Kentucky, shows typical **TIMM** circuits to **MILITARY SYSTEM DESIGN's** Editor Claude Morrison. In this exclusive interview, Mr. Haase explains the philosophy and techniques of Thermionic Integrated Micro-Module circuitry. This new attack on the barriers of heat and radiation to electronic reliability, G. E. utilizes the heat, largely sidesteps radiation effects.

MSD Interviewer—"What are TIMM circuits?

Mr. Haase—"They are 'Thermionic Integrated Micro-Modules'—a new approach to compact, efficient electronic circuitry which employs tiny thermionic tubes totally integrated with specially developed resistors, capacitors and inductors, bonded into tiny circuit modules. They efficiently utilize the heat generated in electronic circuitry instead of wasting it. TIMM circuits have been designed to operate at 580° C. This temperature is maintained by surrounding the circuitry with thermal insulation to contain the power dissipated in the tubes and resistors."

Q.—Are TIMM circuits, then, basically a "repackaging" of components?

A.—No. The TIMM circuit approach has been directed toward the development of *functional electronic elements* designed to yield high systems reliability under severe mechanical, thermal and radiation environmental conditions.

Q.—How does the TIMM circuit approach to the thermal problem differ from conventional approaches?

A.—The TIMM approach takes advantage of temperature and power density increases inherent in microminiaturization. Normally, at some level of miniaturization, it is necessary to remove heat generated by lossy circuit elements. Further miniaturization requires additional heat transfer equipment. Thus minimum system size becomes defined not by the components alone; but also by the type of cooling system which can be employed; the duty cycle of the equipment; and the functional mission profile. In the TIMM system, heat which is needed to develop thermionic emission is obtained by merely conserving the normal dissipations of both active and passive circuit elements by containing this energy within a suitably insulated enclosure. By this means we can generate any temperature desired, in our case 580° C., and essentially obtain electron emission free.

Q.—What level of stability, as it is affected by heat, can be maintained?

A.—A very high level of stability can be obtained because the entire circuit operates at a constant relatively high temperature. Temperature sensors within the functional stacks serve to maintain the regulated operating temperature whenever external or functional conditions change.

Q.—How are TIMM circuits made?

A.—By evacuating and sealing together ceramic spacers, electrodes made of titanium, specially-made resistors, inductors and capacitors. The method used provides constant gas gettering for all the electronic components so that a high level of vacuum is maintained for each circuit element. A wide variety of component combinations can be obtained to produce circuits for nearly any required application.

Q.—What outstanding features do TIMM circuits offer?

A.—In addition to the size, weight and temperature advantages inherent in the use of TIMM circuits, these new components are capable of operating in high radiation fields of both the pulse and steady-state type. This may be extremely important for military electronics applications.

Q.—Why are TIMM circuits tolerant of high-level radiation?

Fig. 1a

FIG. 2
pacitar
speed

Electronic Systems Design

Fig. 1a

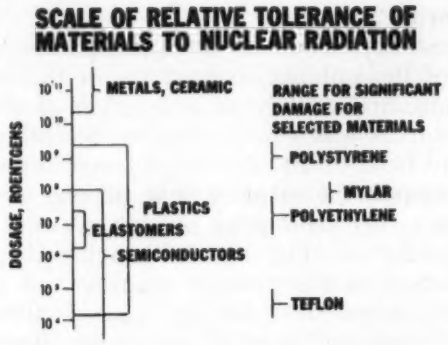


Fig. 1b

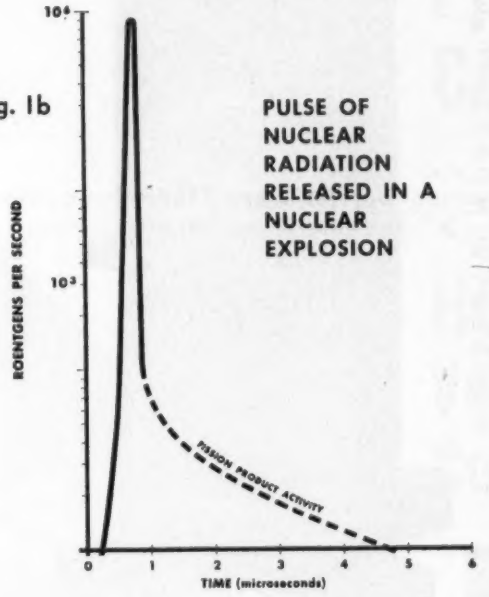

PULSE OF NUCLEAR RADIATION RELEASED IN A NUCLEAR EXPLOSION
ROENTGENS PER SECOND
FISSION PRODUCT ACTIVITY
TIME (microseconds)

FIG. 1. (a) NUCLEAR radiation strongly ionizes many plastics, most semiconductors. Metals and Ceramics used in TIMM's have high radiation tolerance. (b) Prompt gamma and neutron pulse (right) released in nuclear explosion can reach hundreds of miles in free space to disable space craft circuitry.

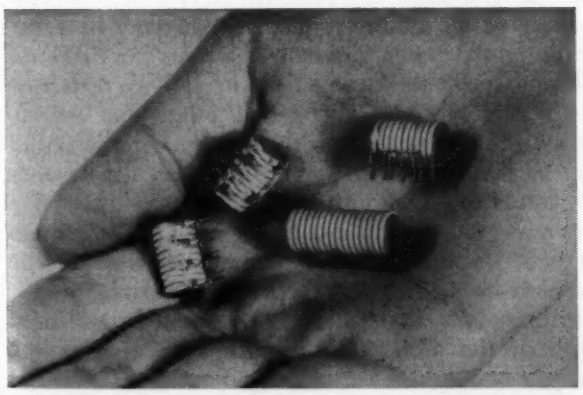
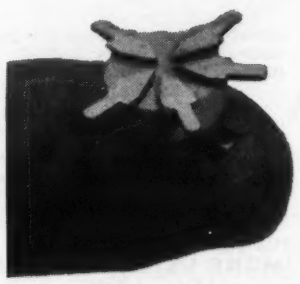


FIG. 2. TIMM CIRCUIT's low interelectrode capacitances give digital computer modules high speed capabilities.



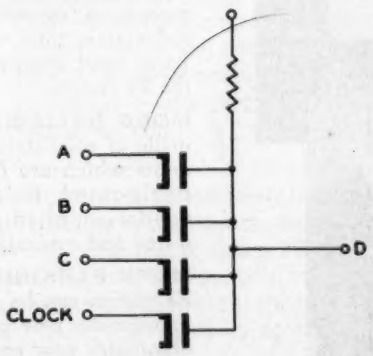


FIG. 3. FUNCTIONAL "AND" logic circuit shown in circuit is materialized in single **TIMM** wafer for stacking with other components in logic circuit.

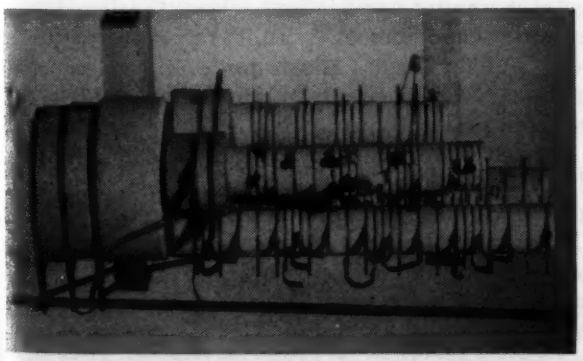


FIG. 4. POWER DIODES and triodes combine with smaller **TIMMs** to provide both high gain and high power outputs in single circuit package.

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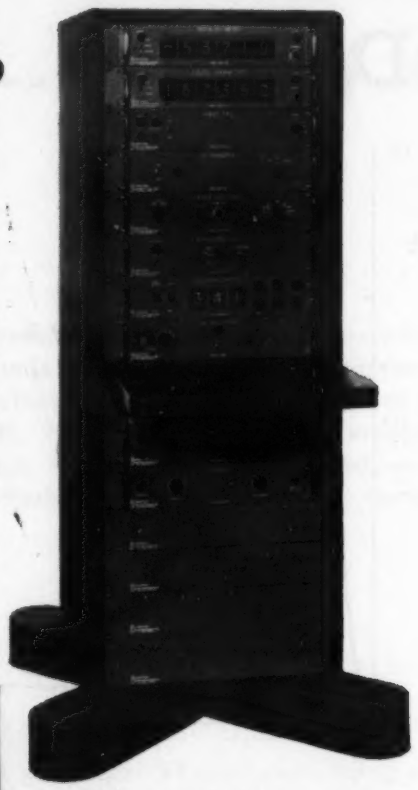

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A.—The specific materials used in TIMM circuits —titanium, platinum, forsterite ceramics, and reconstituted mica—all have high tolerance to radiation. Further, at the elevated temperatures at which TIMM circuits operate, changes in conductivity of the dielectric materials due to radiation effects are minimized. And high temperature operation also offers greater resistance to displacement effects. (See Fig. 1a.)

Q.—What is the effect of gamma and neutron pulse radiation from a nuclear explosion on electronic equipment?

A.—Generally, when an atomic explosion occurs, many of the radioactive products of the reaction are attenuated rapidly as a function of distance. The neutrons and gamma rays on the other hand are very hard to attenuate and travel outward at approximately the speed of light, passing any given point as a very short pulse of high intensity, penetrating radiation (Fig. 1 b). Although perhaps only one percent of the prompt neutrons and gamma photons escape the densely packed fissionable material and enclosure of an atomic device, the amount of energy involved is so great that the radiation pulse amplitude can cause serious malfunctions in electronic equipment located many miles from the explosion.

Q.—How is the radiation effect translated into distance?

A.—The distance at which ordinary electronic equipment malfunctions may be expected to occur is of course dependent upon the "size" of the explosion and its location with respect to the equipment. Our calculations show that a pulse of radiation has the most far reaching effect and in free space even a modest atomic weapon may be capable of interrupting circuits operating hundreds of miles away by subjecting them to a peak dose rate of 10^7 R/sec at that range. It might be well to mention that even though the radiation pulse width may be only one or two micro-seconds, the secondary results of ionization in a dielectric material may take many seconds to recover or may result in high currents through circuit elements leading to the complete failure of the device. In digital circuits, data being processed may be completely lost as a result of the momentary failure even though the equipment might be undamaged otherwise.

Q.—In what applications are TIMM circuits particularly useful?

A.—Applications for TIMM circuits cover nearly all areas of military electronic circuitry. The typical TIMM circuits shown in Fig. 2, are designed for digital computer applications where the low interelectrode capacitances permit response to high speed signals. Fig. 3 illustrates one version of a functional "AND" circuit in which four diodes and a resistor are built into a single TIMM wafer which, in computer applications, would be stacked with other components connected as bistable flip-flops, pulse drivers, clocks, etc.

In other application areas, those of servo systems and communications equipments, it is usually necessary to provide several watts of output power. Here the flexibility of the TIMM approach pro-

vides power diodes and triodes designed to handle 100 milliamperes. These can be combined with smaller TIMM modules as in Fig. 4 to provide both high and low power stages and still retain good thermal efficiency and small size.

Q.—How does the degree of miniaturization of equipment that can be achieved with TIMM circuits compare with that of other miniaturization approaches?

A.—As an example, careful calculations and measurements of typical digital equipment have been made and it appears that the weight and volume of TIMM circuits are about one-tenth the weight and one-eighth the size of modern, well packaged transistorized circuits now in production.

Q.—Does that mean that this approach will give us a 10 to 1 weight reduction for electronic equipment?

A.—No! That reduction would apply to the circuitry and is about the same magnitude of weight saving offered by other micro module approaches.

It should be noted that a systems comparison should not be limited to circuit elements alone, but must also consider the weight, volume, and power requirements of the chasses, mounting hardware, connectors, thermal system for heating, cooling or controlling the operation of electronic equipment; the power supplies, both regulated and unregulated, and the physical requirements for the generator or other prime power sources which may be needed in the installation. In other words the whole system should be considered when an evaluation of weight and volume is important.

Q.—How do TIMM circuits measure up to conventional component criteria?

A.—TIMM circuits feature mechanical ruggedness resulting from the integral construction method of brazing all components into a single assembly. Electrical overload characteristics due to surges, switching transients or testing procedures are excellent. Thermal overload tolerance is substantial since all the components are processed in excess of 1000° C while normal operation is at only 580° C. TIMM circuits embody low lead inductance and because the entire system is small we are able to realize low signal transit time from circuit to circuit. Many circuit components are integrally connected, reducing the number of connections which need be made. Inherently, TIMM circuits possess reliability potential unmatched by conventional component assemblies.

Q.—What basic effect does the use of TIMM circuitry have on equipment design?

A.—The electronic design of equipments will be raised from the component to the functional circuit level, simplifying specification requirements and leading to increased equipment reliability. The very nature of TIMM circuitry directs the attention of the designer to the simultaneous solution of the electrical, mechanical and thermal design problems rather than to their sequential consideration. This implies that we will be giving electronic system design very careful mechanical and thermal consideration right from the beginning of the problem.

FOR MORE INFORMATION CIRCLE 101 ON READER-SERVICE CARD

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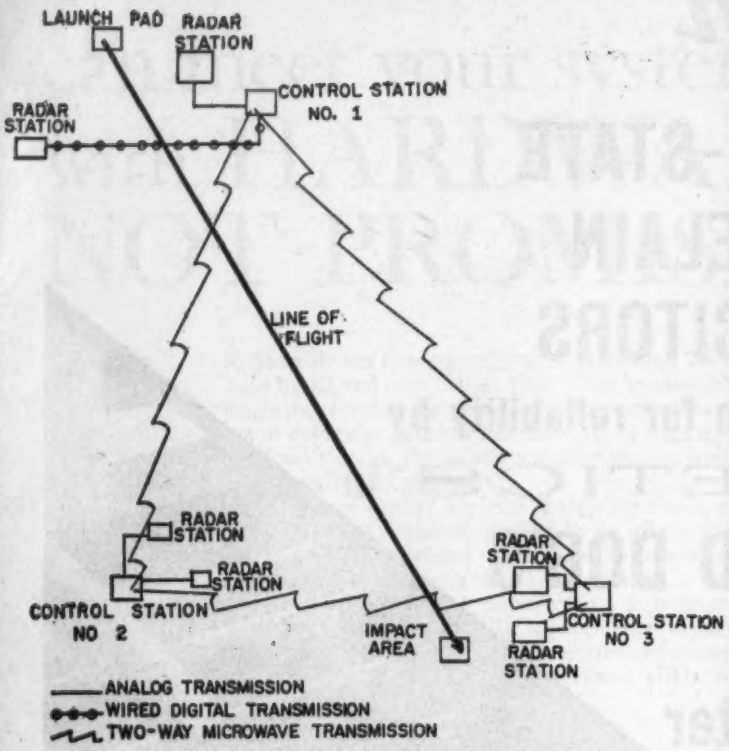


FIG. 1. **TYPICAL** Missile range.

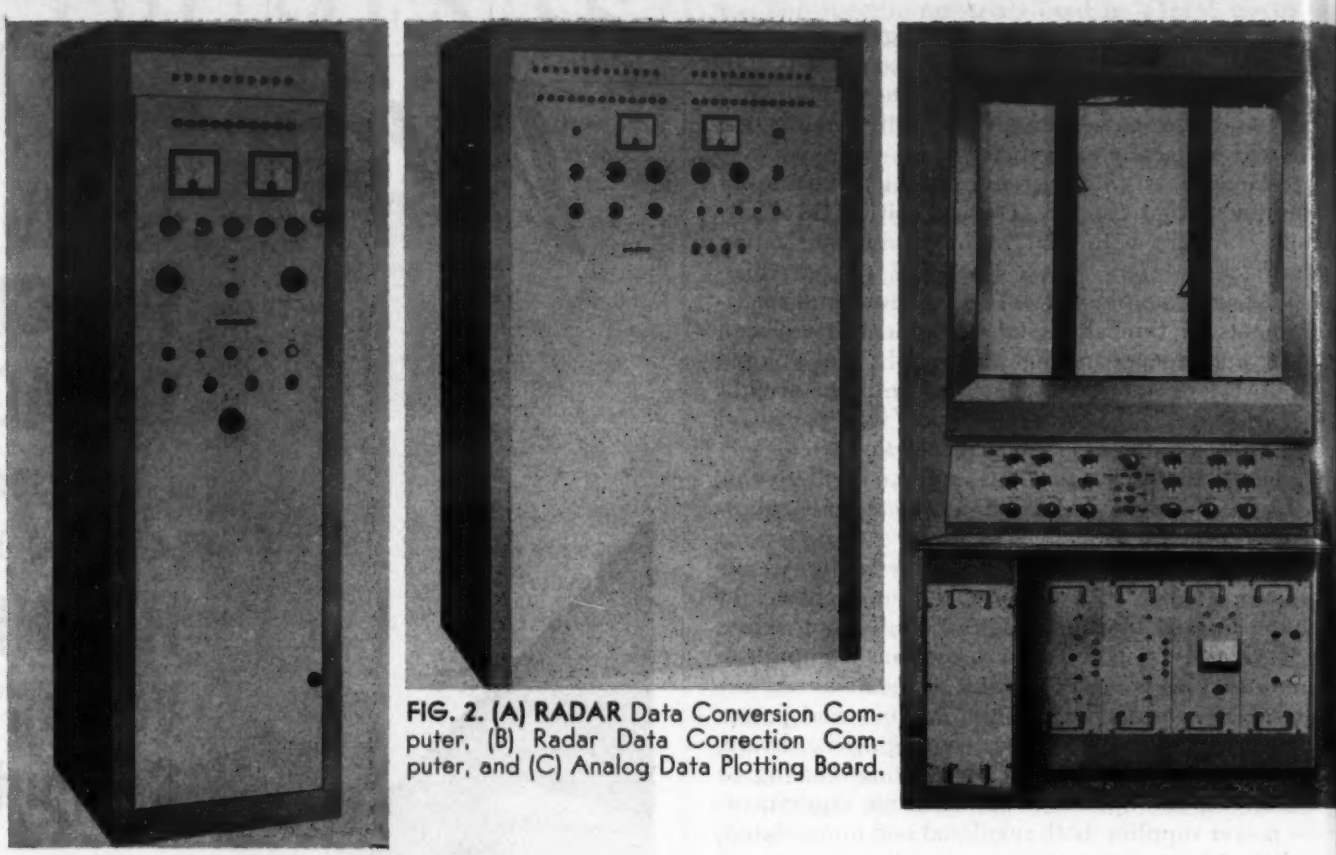


FIG. 2. **(A) RADAR** Data Conversion Computer, (B) Radar Data Correction Computer, and (C) Analog Data Plotting Board.

Analog Computers and Long-Range Missiles

CHARLES B. HUSICK
Vice President-Engineering

WILLIAM K. FALLON
Director of Technical Publications
Computer Systems, Inc.

A MISSILE hurtles towards its destination at supersonic speed. Automatic tracking radars acquire its signal and track its flight. Remote control stations receive trajectory data and control other down-range radar sets accordingly. Simultaneously high-precision, high-speed computers translate, correct and report the trajectory and control data between stations in a matter of microseconds. This is the story of missile range instrumentation.

The great need for high-speed, high-precision computation devices in missile range instrumentation has opened up a tremendous field for application of special purpose analog computers. The compact size of this type of computer as well as its natural implementation with an automatic plotting board make it ideal for such applications. Computer Systems, Inc., has developed and manufactured a group of missile range instrumentation analog computers which have completed hundreds of hours of operation at military establishments throughout the country.

Typical Instrumentation Chain

In order to illustrate the function of analog computers in missile range applications, let us consider an instrumentation chain such as the one shown in Fig. 1. The arrangement consists of six radar sets and three control stations. A missile is to be tracked throughout its entire flight to the target. The radar sets are positioned at different locations so that continuous surveillance of the missile can be maintained. Each radar set sends current trajectory data to its associated control station. The Test Director and the Safety Officer are stationed at Control Station 1, the central station, where trajectory data is displayed on plotting boards throughout the entire flight. In addition, each tracking station down-range is continuously supplied with the position of the missile in relation to its own location and any radar station in the chain must be capable of supplying intercept commands to any other tracking station. The three control stations maintain continuous contact between radar and associated theodolite stations and control the stations accordingly.

A polar-to-Cartesian data conversion computer and associated plotting and recording equipment are located at each radar station to convert data for transmission to the associated control station. At Control Station No. 1, two correction computers and associated plotting and recording equipment are used. In addition, a Cartesian-to-polar data conversion computer at each radar site, converts Cartesian correction data from its associated Control Station to polar form for target acquisition purposes (Fig. 2).

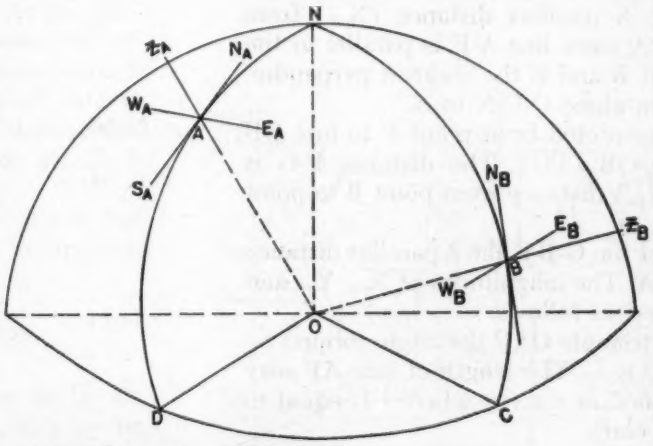
The two computers at Control No. 1 accept data from the nearby radars and from Control Stations 2 and 3, and correct that data for earth's curvature, parallax, axis tilt and rotation. Control Stations 2

and 3 each have one such computer and associated plotting and recording equipment for the same purpose.

Two major computation problems encountered in missile range instrumentation are: 1) Translation of tracking data from one radar station to another and the display of this data in relation to the position of the receiving radar station, and 2) the correction of the data for the curvature of the earth's surface.

Translation of Radar Coordinates

Whenever target tracking data from a radar is utilized at a remote location which is more than a few miles away from the set and which must "see" the tracked object in relation to its own position, the effect of the spherical shape of the earth on the relationship between the coordinate axes and, consequently, on the data must be considered. Target data from a tracking radar is normally translated from polar to Cartesian form for use at the radar location. The Cartesian coordinate data from the radar station is then transmitted to the remote site and presented there in relation to that site. An illustration of this is shown in Fig. 3.



A = REMOTE RADAR INSTALLATION
B = LOCAL I RADAR INSTALLATION
O = CENTER OF SPHERE

FIG. 3. TRANSLATION of data from one radar location to another.

The spherical shape of the earth causes the respective coordinate systems of the radar site and the remote site to be considerably misaligned with respect to each other when viewed from a common reference point. The misalignment affects the N-S (±Y) and Z (altitude) axes in cases where the two locations are located on the same line of longitude and the E-W (±X) and Z (altitude) axes in cases where the two locations are located on the same line of latitude. All three coordinate axes are affected when the remote location is displaced in both latitude and longitude from the local site.

The radar site and the remote location are represented as A and B, respectively, in Fig. 3. Point A lies in plane O-D-N; point B lies in plane O-C-N. The North-South (±Y) axis of the coordinate system at A lies in plane O-D-N; the East-West

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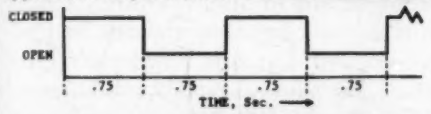

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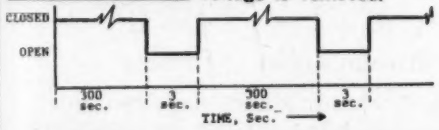

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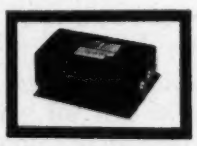

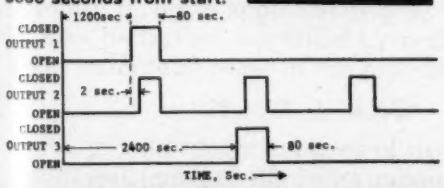

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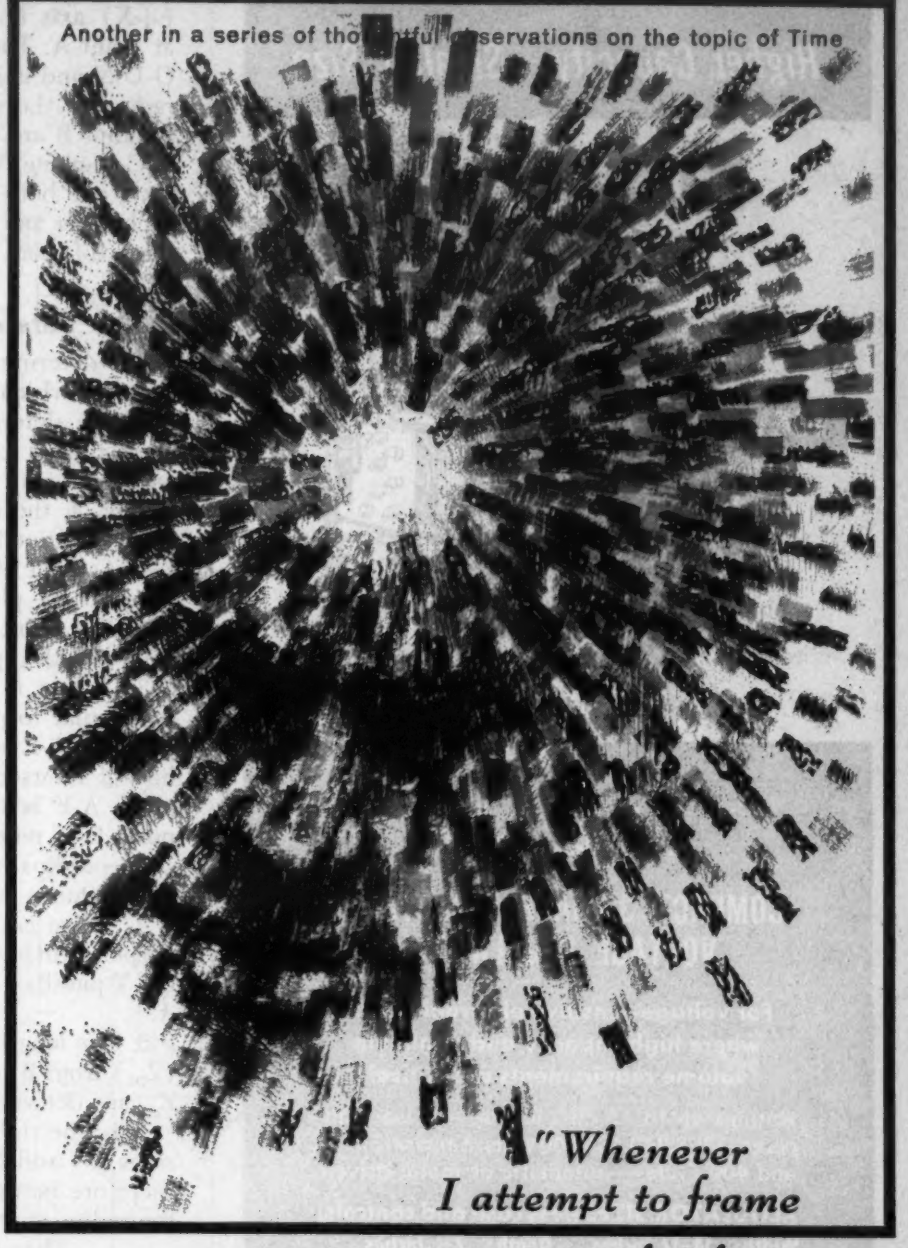
CIRCLE 9 ON READER-SERVICE CARD

Another in a series of thoughtful observations on the topic of Time



"Whenever I attempt to frame a simple idea of Time, abstracted from the succession of ideas in my mind, I am lost and embrangled in inextricable difficulties"

GEORGE BERKELEY, English Metaphysical Philosopher, 1685-1753

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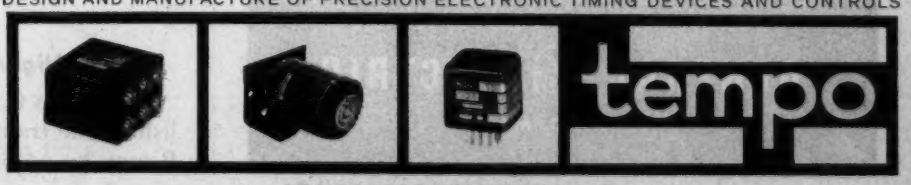

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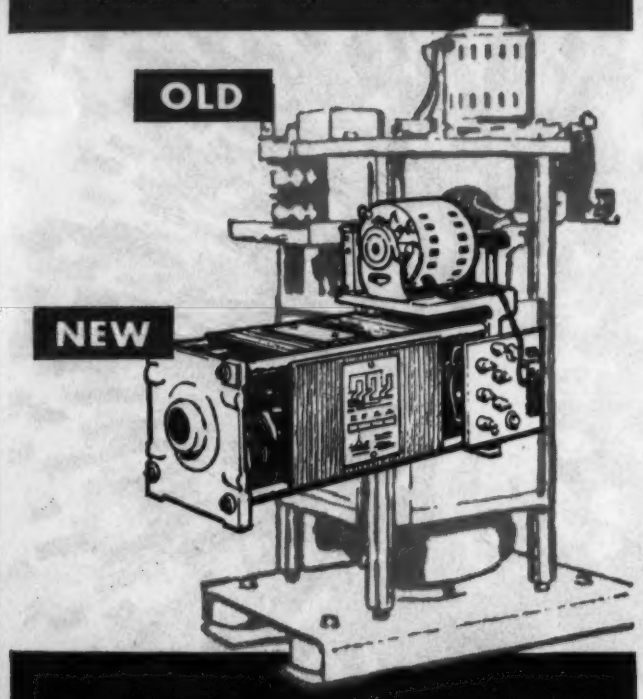

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(+X) axis is perpendicular to the plane O-D-N at point A. The altitude axis (Z) lies in the plane O-D-N and is an extension of line OA which is the radius of the sphere. The coordinate system axes at point B are located similarly with respect to the O-C-N plane. We may say that the coordinate systems are both rotated and tilted with respect to each other and we must correct for misalignment in three different directions.

Determination of Site Parallax

To determine the site parallax, the distance through which the coordinate data are translated must be determined. This translation or parallax correction is carried out in Cartesian coordinates and consists of corrections in X, Y and Z. Referring to Fig. 4, the magnitudes of the three corrections are determined as follows:

1. A great circle is constructed from point A to intersect the plane O-C-N perpendicularly at E.

2. The point of intersection (E) is joined to the center of the sphere (O) by radius O-E (Fig. 4).

3. A line is constructed from A which is perpendicular to plane O-C-N. This line (A-F) lies in plane O-A-E and intersects plane O-C-N on the line of intersection of the planes (O-E). The distance A-F is the X parallax distance (X_{px}) from point B to point A since line A-F is parallel to the ±X coordinate at B and is the shortest perpendicular distance from plane O-C-N to A.

4. A line is constructed from point F to line OB perpendicular to OB (FG). The distance F-G is the Y parallax (Y_{px}) distance from point B to point A.

5. The length of the G-B is the Z parallax distance (Z_{px}) from B to A. The magnitudes of X_{px}, Y_{px} and Z_{px} are determined as follows:

1. In the right triangle OAF the angle formed by sides AO and FO is τ_1. The length of side AF may therefore be defined as $r \sin \tau_1$ where r is equal to the radius of the earth.

Therefore:

$$r \sin \tau_1, = AF = X_{px} \qquad (1)$$

where τ_1 = spherical angle subtended by arc A-E on surface of the sphere.

2. In the right triangle OFG, the angle formed by sides FO and GO is τ_2. Since the length of side OF may be defined as $r \cos \tau_1$, the length of side FG may be expressed as

$$r \cos \tau_1 \sin \tau_2 = FG = Y_{px} \qquad (2)$$

where τ_2 = 90°—(latitude of point "B"—b), where b is the spherical angle subtended by arc N-E on the surface of the sphere.

3. Similarly, in the right triangle OFG, the side OG may be defined as $r \cos \tau_1 \cos \tau_2$. Since Z_{px} is equal to distance GB which also equals OB —OG (or r—OG),

$$r - r \cos \tau_1 \cos \tau_2 = Z_{px} \qquad (3)$$

Alignment of Coordinate Axis

When the Cartesian parallax distances are established, the translation of data from point A to point B may be accomplished by aligning the coordinate

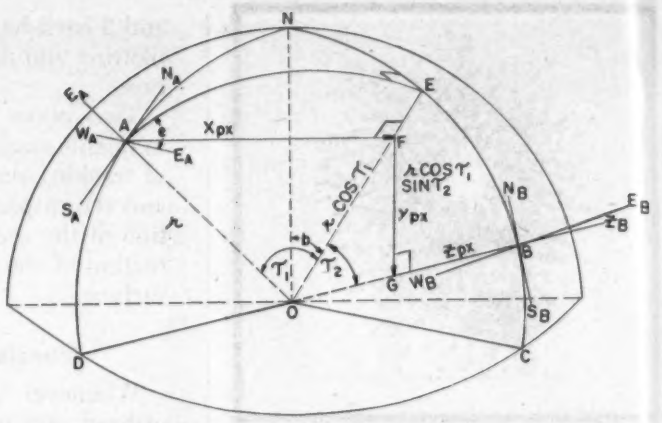

FIG. 4. DETERMINATION of Magnitude of corrections in X, Y and Z.

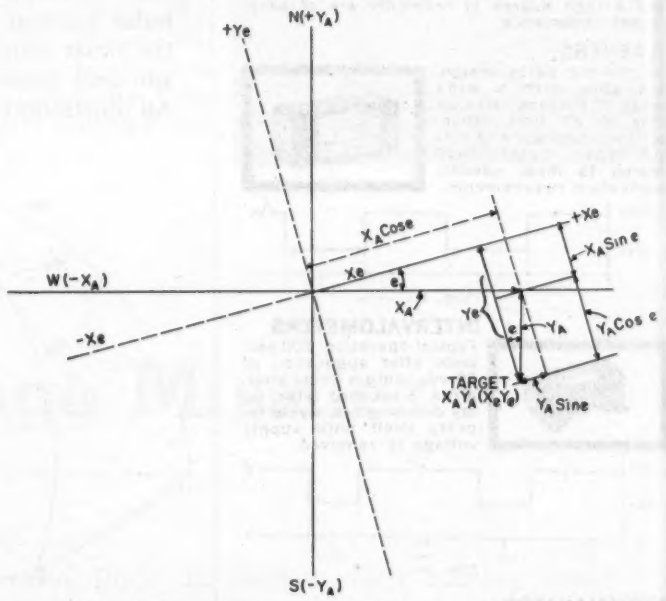

FIG. 5. ROTATION of coordinates about the Z axis at A.

axis at A with the coordinate axis at B (Fig. 4) in three successive steps.

1. The X and Y axes are initially aligned by rotation of the coordinate system at A about the Z axis through an angle e to bring the E-W axis at A into line with the great circle through A which is perpendicular to the longitude line at point E. As shown in Fig. 5, new coordinates X_e, Y_e of the target previously designated X_A, Y_A will now be

$$X_e = X_A \cos e - Y_A \sin e \qquad (4)$$

$$Y_e = X_A \sin e + Y_A \cos e \qquad (5)$$

2. The coordinate axes at A are then tilted

through an angle τ_1 about the rotated Y axis at A, to align the X axis parallel to the X axis at B. This is accomplished, as shown in Fig. 6, by the equations:

$$X_{\tau_1} = X_e \cos \tau_1 - Z_A \sin \tau_1 \quad (6)$$

$$Z_{\tau_1} = X_e \sin \tau_1 + Z_A \cos \tau_1 \quad (7)$$

3. The third step is to tilt the coordinate system at A about the X rotated axis through angle τ_2 to complete its alignment with the coordinate system (Fig. 7,) giving rise to equations:

$$Y_{\tau_2} = Y_e \cos \tau_2 - Z_{\tau_1} \sin \tau_2 \quad (8)$$

$$Z_{\tau_2} = Y_e \sin \tau_2 + Z_{\tau_1} \cos \tau_2 \quad (9)$$

The formulae derived above may be mechanized quite readily by standard analog computation techniques. A computer logic diagram for coordinate data translation is shown in Fig. 8.

Correction of Data for Earth's Curvature Effect

The Cartesian coordinates of a tracked target may be derived from the slant range, elevation angle and azimuth angle data presented by the Tracking Radar equipment (Fig. 9). These data will be suitable for use in plotting purposes in all cases where the total horizontal ground range to the target does not exceed a few miles. As the horizontal ground range to the target increases, the effect of the curvature of the earth becomes increasingly apparent and requires correction of data to account for this curvature effect. Fig. 10 illustrates the derivation of the corrected altitude which is designated H.

The true value of target altitude above the earth's surface (H) may be derived by an application of the following expression:

$$H = [(Z + r)^2 + R_o^2]^{1/2} - r \quad (10)$$

where r = radius of earth.

This equation yields the exact value of H. By application of the binomial expansion, it may be reduced to the following form:

$$H = Z + R^2_o/2\,(Z + r) \quad (11)$$

This simplified expression provides sufficient computation accuracy for use with ground range distance R_o up to approximately six-hundred miles. It may be further simplified by neglecting the ½ Z term which will result in the expression:

$$H = Z + R_o^2/2r \quad (12)$$

For ground ranges in excess of six-hundred miles, additional terms of the series expansion or the exact formula, equation 10 must be utilized.

The problems encountered in the correction and translation or radar data readily lend themselves to analog techniques. At Computer Systems, we are developing a compact range instrumentation computer which combines the best features of analog and digital machines. While analog in design, it also includes a memory which has proven to be quite effective on our larger computers. This we consider the ideal combination for missile range applications.

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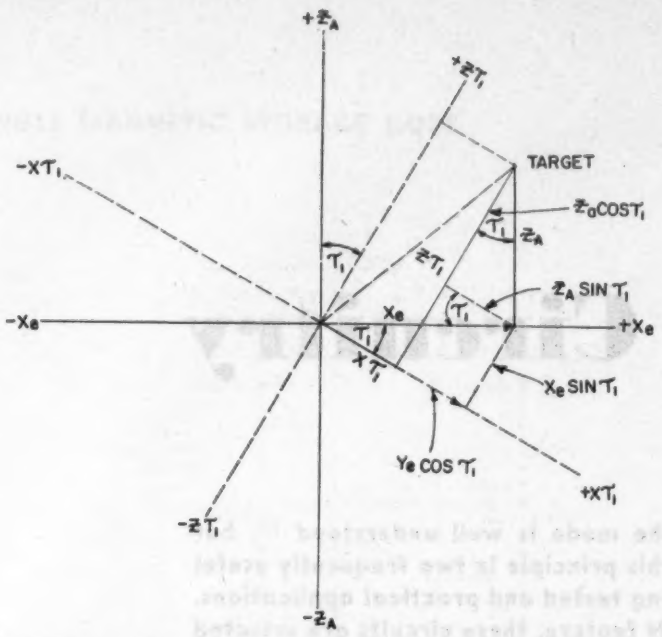


FIG. 6. TILT of the coordinate axes at A about the rotated Y axis at A.

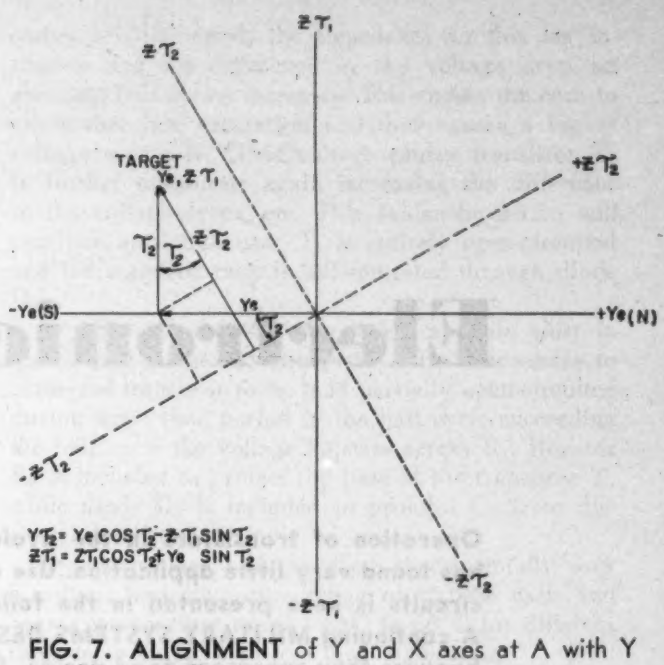


FIG. 7. ALIGNMENT of Y and X axes at A with Y and X axes at B.

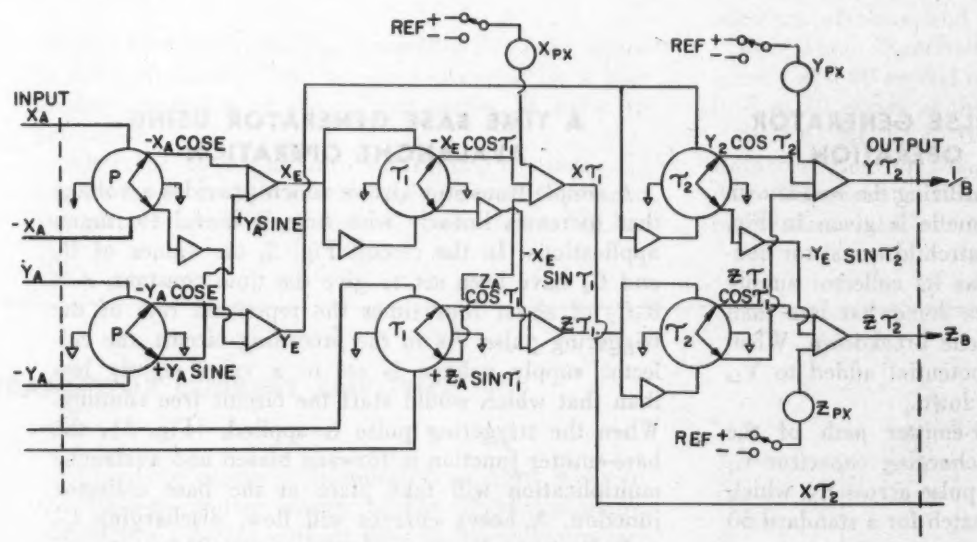


FIG. 8. COORDINATE Data Translation computer logic diagram.

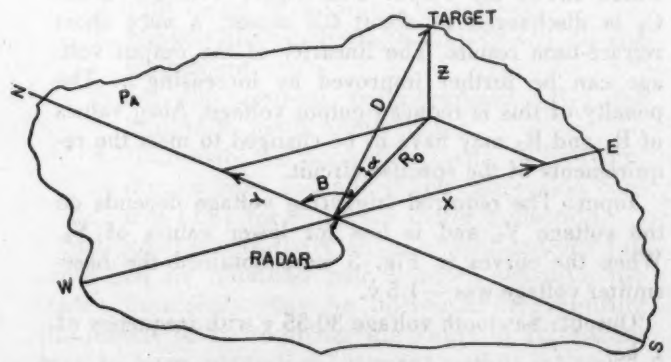


FIG. 9. DERIVATION of X, Y, Z, and R.

$R_o = D \cos \alpha$, $x = R_o \sin \beta = D \cos \alpha \sin \beta$, $y = R_o \cos \beta = D \cos \alpha \cos \beta$, $z = D \sin \alpha$.

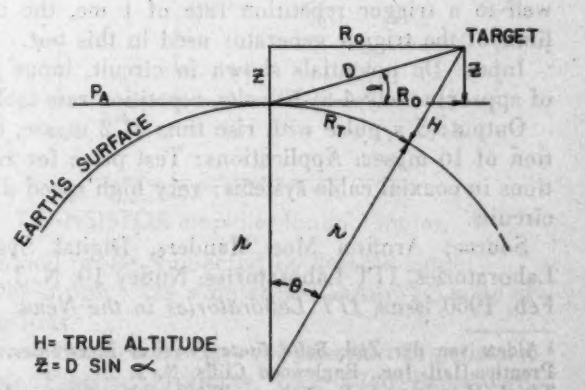


FIG. 10. DERIVATION of H. $H = [(z + r)^2 + R_o^2]^{1/2} - r$ where $Z = D \sin \alpha$.

Electronic Circuitry

Operation of transistors in the avalanche mode is well understood [1,2], but has found very little application. Use of this principle in two frequently useful circuits is here presented in the following tested and practical applications. A continuing MILITARY SYSTEMS DESIGN feature, these circuits are selected because they represent good design. Significant characteristics which are not self-evident from the diagram are explained in the printed commentary.

MILLIMICROSECOND PULSE GENERATOR USING AVALANCHE OPERATION

A practical transistor circuit utilizing the well-known but seldom applied avalanche mode is given in Fig. 1. In this circuit Q_1, an NPN Fairchild transistor connected as a common emitter has its collector supply voltage V_{ce} adjusted to a value somewhat less than that required to initiate avalanche breakdown. When the trigger pulse appears, its potential added to V_{ce} will initiate the avalanche breakdown.

At breakdown, the collector-emitter path of the transistor conducts heavily, discharging capacitor C_1 and producing a negative-going pulse across R_3, which also provides a low impedance match for a standard 50 ohm cable.

The output voltage from this circuit is a pulse with a rise time of 2 milli-microsecond, a duration of 16 mμsec, and an amplitude of about 5 v. It will respond well to a trigger repetition rate of 1 mc, the upper limit of the trigger generator used in this test.

Input: Dc potentials shown in circuit, input pulse of approximately 4 to 10 volts, repetition rate to 1 mc.

Output: 5 v pulse with rise time of 2 mμsec, duration of 16 mμsec. Applications: Test pulse for reflections in coaxial cable systems; very high speed digital circuits.

Source: Arnfinn Moe Manders, Digital Systems Laboratories, ITT Laboratories, Nutley 10, N. J., also Feb. 1960 issue, *ITT Laboratories in the News*.

[1] Aldert van der Zeil, *Solid State Physical Electronics*, 1957, Prentice-Hall, Inc., Englewood Cliffs, N. J.
[2] D. J. Hamilton, J. F. Gibbons, W. Shockley, "Physical Principles of Avalanche Transistor Pulse Circuits," *IRE Proceedings*, Vol. 47, No. 6, pp. 1102-1108, June 1959.

A TIME BASE GENERATOR USING AVALANCHE OPERATION

A simple transistor circuit which provides a voltage that increases linearly with time is useful for many applications. In the circuit Fig. 2, the values of R_3 and C_2 have been set to give the time constant, $\tau = R_3C_2$ of about four times the repetition rate of the triggering pulse. As in the preceding circuit, the collector supply voltage is set to a value sightly less than that which would start the circuit free running. When the triggering pulse is applied, (Fig. 3), the base-emitter junction is forward biased and avalanche multiplication will take place at the base collector junction. A heavy current will flow, discharging C_2 and dropping V_o to its lowest point. This cuts off conduction and C_2 is slowly charged through R_3.

The performance of the circuit is shown in Fig. 3, which shows the output and trigger voltages. Since C_2 is discharged in about 0.5 mμsec, a very short retrace-time results. The linearity of the output voltage can be further improved by increasing τ. The penalty of this is reduced output voltage. Also, values of R_1 and R_2 may have to be changed to meet the requirements of the specific circuit.

Input: The required triggering voltage depends on the voltage V_b and is less for lower values of V_b. When the curves in Fig. 3 were obtained the base-emitter voltage was —1.5 v.

Output: Sawtooth voltage 30-55 v with frequency of 1 kc.

Applications: Timing circuits and CRT deflection circuits.

Source: Same as preceding circuit.

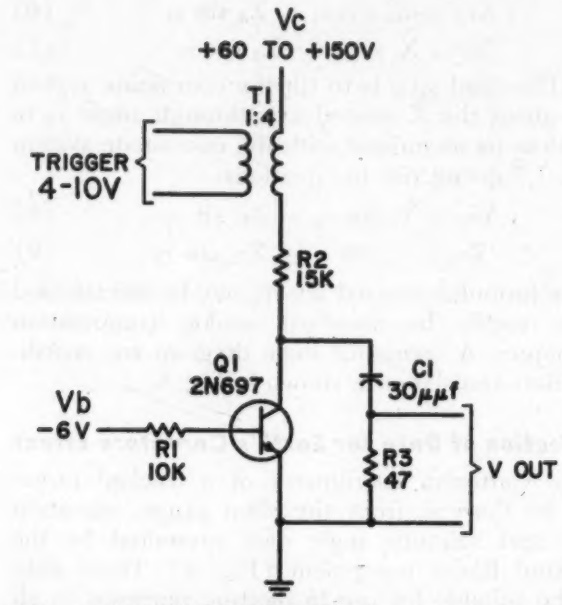


FIG. 1. MILLIMICROSECOND transistor pulse generator uses avalanche operation.

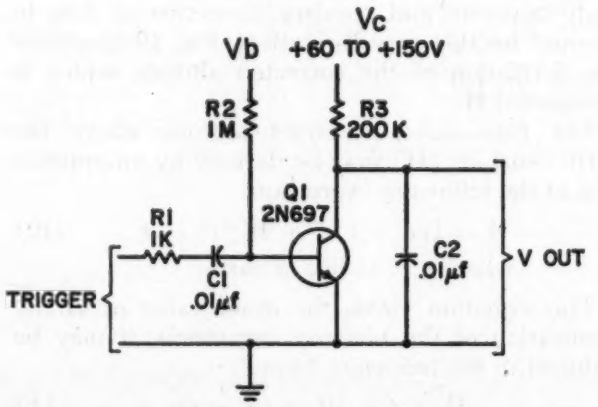


FIG. 2. TIME BASE generator designed for 1 KC, has application in CRT deflection circuits

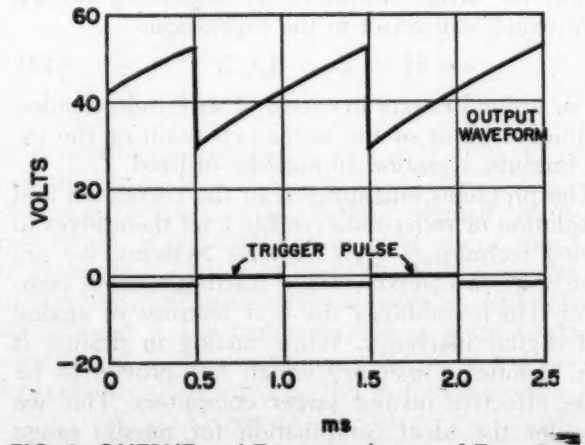


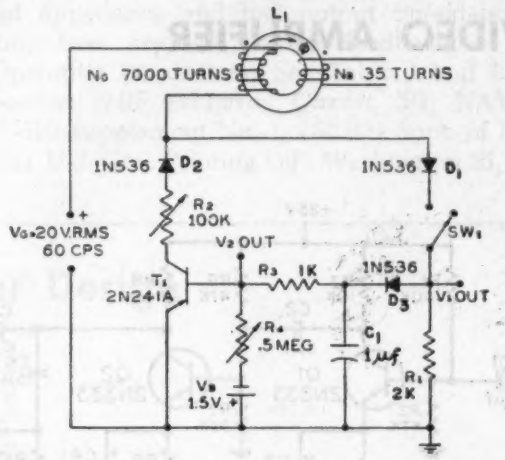
FIG. 3. OUTPUT and Trigger voltages of Time Base Generator.

LONG TIME DELAYS FROM A SINGLE MAGNETIC STORAGE CORE

Time delays in the following circuit are achieved by alternately pulsing a magnetic core with positive and negative volt-second pulses. The difference between the negative and positive pulses is adjusted to be a few microvolt-seconds. The length of the time delay is determined by the number of times this difference must be applied to the core in order to change the flux level from one saturation to the other. Since as many as 7000 pulses can be applied to a core before saturation is reached, 60-cycle pulses taken from the power source can be used to provide delays up to 2 minutes from a single stage delay.

In the circuit shown, the core is excited with an asymmetrical ac voltage. This is accomplished in one of three ways: 1) by making R_1 and R_2 different in value; 2) by making R_1 and R_2 equal and biasing the magnetic core with dc current through the bias winding N_b, or 3) by introducing a dc potential in series with the ac excitation. Each of these methods has the effect of causing the core voltage to assume different volt-second values on alternate half cycles. Timing is initiated when switch S_1 is closed.

During the timing intervals, the magnetic core changes its flux level from its negative saturation level to the positive saturation level. The amount of time necessary for this to occur will depend on the difference between the circuit voltage drops on alternate half cycles, this being adjusted by varying the difference between R_1 and R_2. Transistor T_1 of the figure is normally biased "on" or short circuited by a bias slightly in excess of the voltage across R_1 prior to saturation.



SOLID STATE delay circuit using single magnetic storage core and one transistor provides time delays from 5 to 120 seconds in duration.

After the core goes into saturation, transistor T_1 can no longer be held short circuited by the bias since the voltage across R_1 increases. As transistor T_1 becomes less saturated, the impedance in this leg increases and the difference in the voltage drop on alternate half cycles increases. This causes the core to go further into saturation and thus causes a higher voltage across R_1. This voltage causes transistor T_1 to further unsaturate again increasing the difference in the voltage drops, etc. This avalanche action will continue until transistor T_1 is entirely open-circuited and the magnetic core is self-saturated through diode D_1.

Capacitor C_1 is used to provide a phase shift in the voltage across R_1. This phase shift is necessary to cause the transistor to be held partially open-circuited during some time period in the half cycle succeeding the half cycle the voltage appears across R_1. Resistor R_2 is included to protect the base of the transistor T_1 while diode D_3 is included to prohibit C_1 from discharging through R_1.

The device has been checked experimentally over a voltage and frequency range of ±10% each and over a temperature range —20° to 60°C for different time delay value, with less than 10% error.

Input: 20v rms, 60 cps.

Output: —20v pulsating dc, 10 ma; step voltage —28 v, 2 ma. intervals.

Delay: Variable from 5 sec to 120 sec; shorter delay intervals such as 0.1 sec to 10 sec are possible by selection of cores and windings.

Rise Time: Nominally 5 cycles of the supply frequency at a 60 second delay and increases to nominally 8 to 10 cycles at the 120 second delay.

Source: Mr. C. E. Hardies, Electrical Development Engineer, Control Div., Magnetics, Inc., Butler, Pa., Also Transactions 59-176, Published in AIEE Communication and Electronics, Nov. 1959, pp. 457-61.

SENSITIVE LIGHT METER USES TRANSISTOR CURRENT AMPLIFIER

Most sensitive light meters use delicate microammeters for indicators. A more rugged (0-1 ma) d-c indicator is used in this circuit, driven by a type 2N34 junction transistor d-c amplifier. Circuit has been used to measure the brilliance of illuminated figures and graduations on aircraft instrument dials.

The light-sensitive element is a Sylvania 1N77A photo-diode. This tiny (0.094" diameter) germanium photo-diode comes with a built-in lens, and was mounted on the tip of a probe made from the case of a plastic mechanical pencil. The 1N77A is connected in series with the 2-megohm load (R_2) across the 22½-v supply battery. When polarity is as shown, the 1N77A is operating on the inverse (back resistance) portion of its characteristic. In the dark, this back resistance is so high that only a few microamperes of diode current flow, and the potential drop across the photodiode load (R_2) is small. When the diode is illuminated, however, its back resistance is lowered and the diode passes a higher current.

When the diode is illuminated, current flows in the base-to-emitter circuit of the 2N34 transistor, producing a larger current flow in the collector circuit, through the 1-ma d-c milliameter. A nominal 20-microampere base current produces full-scale meter deflection.

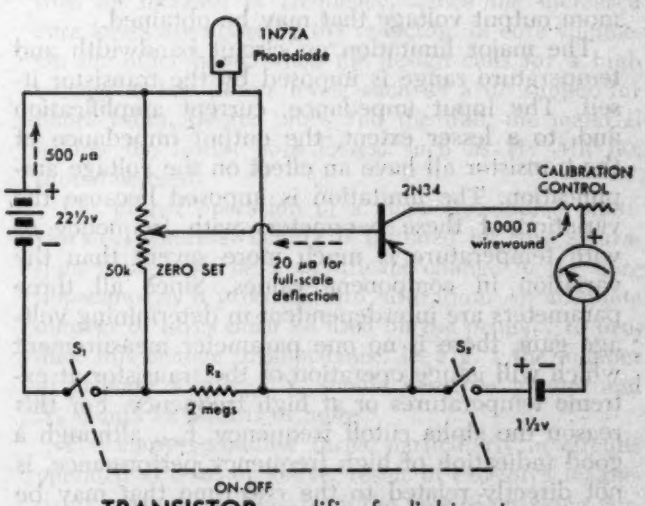
The light meter is calibrated as follows:

1. Darken the photodiode and switch on the instrument.
2. Set the zero-set potentiometer (R_1) for minimum meter deflection.
3. Illuminate the photodiode with 70 foot-candles of light and adjust the calibration control (R_3) for full-scale meter deflection.

Still greater sensitivity than 70 foot-candles full scale can be obtained with a more sensitive d-c meter. Sensitivity may be decreased by shunting the meter, or by reducing the value of R_2, taking care to keep photodiode current within ratings.

Sensitivity: 70 foot-candles full scale with 0-1ma meter.

Size: Instrument was built in a 3" x 4" x 5" box,



TRANSISTOR amplifier for light meter.

with pencil probe connected by flexible cable.

Power supply: 22½ v dc at 500 μamp; 1.5 v dc at 1.0 ma max.

Source: Booklet, 28 *Uses for Junction Transistors*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y. *Also* 100 *Electronic Circuits, Vol.* 2, Instrument Publishing Co., Pittsburg 12, Pa.

SILICON TRANSISTOR VIDEO AMPLIFIER

Circuit NBS—Navaer PC 201 (Fig. 1) is a high-gain intermediate-level (±2.0 volts maximum output) transistor video amplifier for use in applications where stability of gain and a wide temperature range are important. It is non-inverting, has an input impedance of 20K, and will operate into loads of 10K or larger. Impedance levels are such that it may be cascaded for additional voltage gain.

Silicon transistors are used to obtain a wide temperature range. Negative feedback of 20 db extends the frequency range and stabilizes the voltage amplification against temperature changes and transistor replacement. Selection of R5 provides for a choice of voltage gain (Table 1).

Either raising the value of R5 or lowering the value of R10 will decrease the voltage amplification with only a slight accompanying change in bandwidth. This situation results from the fact that changing either R5 or R10 in a direction to decrease voltage amplification decreases the loop voltage gain, A_o, while increasing the feedback factor, B. Thus the change in magnitude of negative feedback, BA_o, is slight, resulting in only a slight increase in bandwidth at the lower gain. Changing R5 is preferred since it will not derate the maximum output voltage that may be obtained.

The major limitation on circuit bandwidth and temperature range is imposed by the transistor itself. The input impedance, current amplification and, to a lesser extent, the output impedance of the transistor all have an effect on the voltage amplification. The limitation is imposed because the variation of these parameters with frequency or with temperature is much more severe than the variation in component values. Since all three parameters are interdependent in determining voltage gain, there is no one parameter measurement which will gauge operation of the transistor at extreme temperatures or at high frequency. For this reason the alpha cutoff frequency, $f_{\alpha co}$, although a good indication of high frequency performance, is not directly related to the rise time that may be achieved with any particular transistor.

Resistors R4 and R9, in conjunction with the biasing resistors, serve to minimize the change in quiescent operating point accompanying temperature variation and transistor replacement. A ratio indicating the relative amount of stabilization may be computed for each stage with the value of unity indicating perfect operating point stabilization.

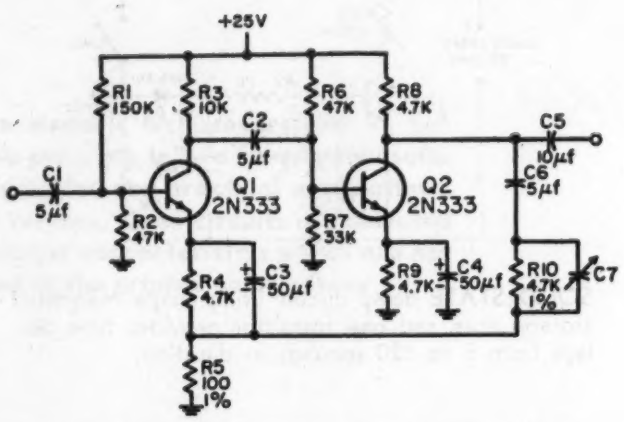


FIG. 1. SILICON TRANSISTOR video amplifier uses NPN 2N333 triodes. New G. E. 2N333A types with dissipation ratings to 500 mw at 25°C are now available. Component variables: R5: Select for desired voltage amplification (See Table I), C7: Between 4 and 30 μμf, to be selected after total output capacitance is determined. R5, R10: ±1% limits; all other R: ±10% limits. All C: ±20% limits. (Note 1).

TABLE 1. PC 201 OPERATING CHARACTERISTICS

	Bias Resistor R5 Values		
	100 ohms	220 ohms	470 ohms
Voltage amplification	45	20	10
Rise Time[2] (150°C)	1.0 μsec	0.9 μsec	0.7 μsec
Rise Time[2] (25°C)	0.5 μsec	0.4 μsec	0.35 μsec
Droop for 500 μsec pulse (—50°C)	3.0%	1.5%	1.0%
Maximum output amplitude[3]	2 v peak	2 v peak	2 v peak
Maximum input amplitude[3]	45 mv peak	100 mv peak	200 mv peak
Input impedance (ohms)	22 K	27 K	32 K
Output impedance (ohms)	250	210	180
Maximum amplification variation with transistor replacement.[4]	±5%	±3%	±2%
Maximum amplification variation with temperature.[4]	+5, —10%	+4, — 7%	+2, — 7%
Minimum load resistance:	10K	10K	10K
Temperature range:	—50°C to 150°C.		

Notes:

1. The performance specifications are based on component values which do not deviate from the nominal by more than the limits specified above. Thus the term "limits" includes the initial tolerance plus drifts caused by environmental changes of aging.
2. Total output capacitance = 30 μμf.
3. Plus and minus from ac zero level.
4. Load resistance = 10 K.

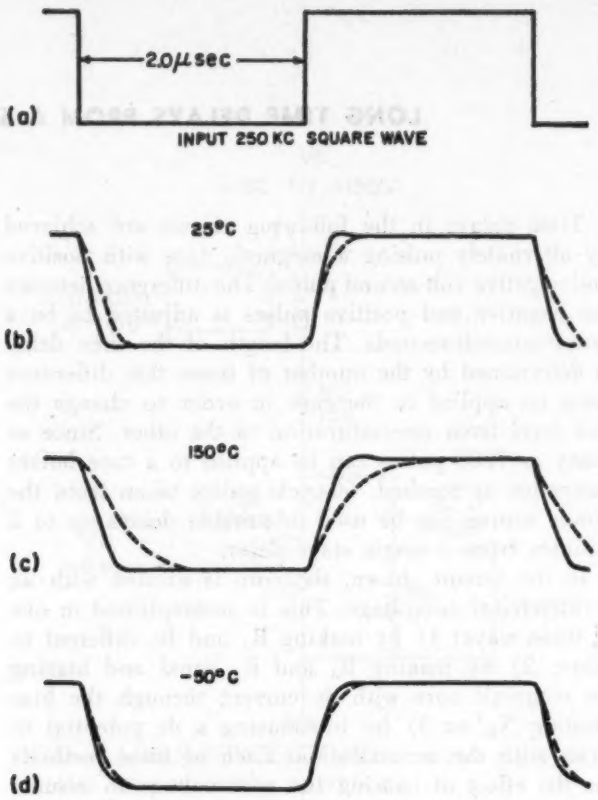


FIG. 2. WAVEFORMS with compensation for two sample pairs of transistors. R5 = 100 ohms, Output = 4v, Total output capacitance = 30 μμf. Compensation for overshoot by C7.

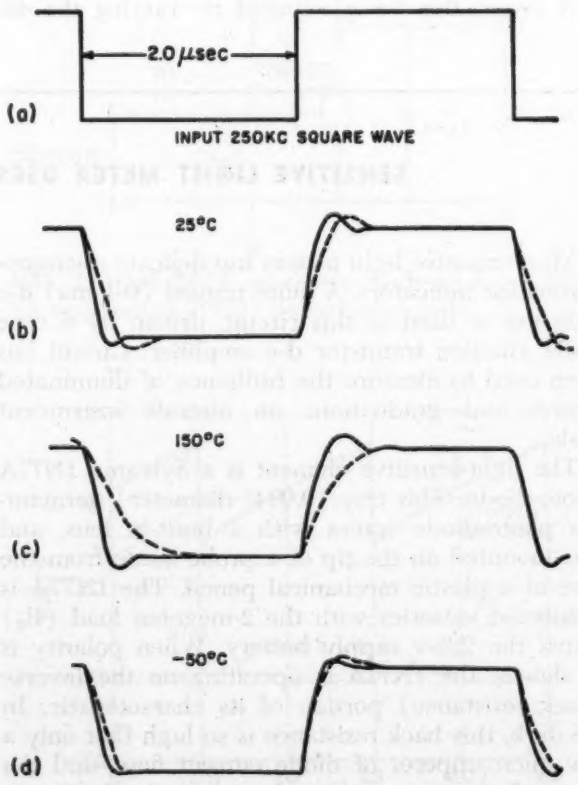


FIG. 3. WAVEFORMS without compensation. Same transistors and circuit values as in Fig. 2, except no compensation for overshoot.

The stabilization ratio for Q1 is

$$Q1 = \frac{h_{fe}}{h_{fe} + 1 + \dfrac{1}{R4/R1 + R4/R2}}$$

where h_{fe} is the common emitter forward current transfer ratio. A similar expression applies to Q2 with R9, R6, and R7 substituted for R4, R1, and R2. The stabilization ratios are 0.8 and 0.87 for for Q1 and Q2 respectively.

Capacitor C7 compensates for overshoot produced by the total capacitance at the output terminals and is to be selected after that capacitance is determined. Its value will be between 4 and 30 $\mu\mu$f for output capacitance values up to 100 $\mu\mu$f (Figs. 2 and 3).

An important aspect of the circuit design is the ability to cascade feedback pairs for additional voltage amplification. This is possible due to the high input impedance and low output impedance resulting from negative voltage feedback.

Operating Parameters: See Table 1 and Fig. 1.

Source: *NBS Preferred Circuit* 201, NAVAER 16-1-519 Supplement No. 1, ($0.60) Supt. of Documents, U.S. Gov. Printing Off., Washington 25, D. C.

DC-DC Converter Design

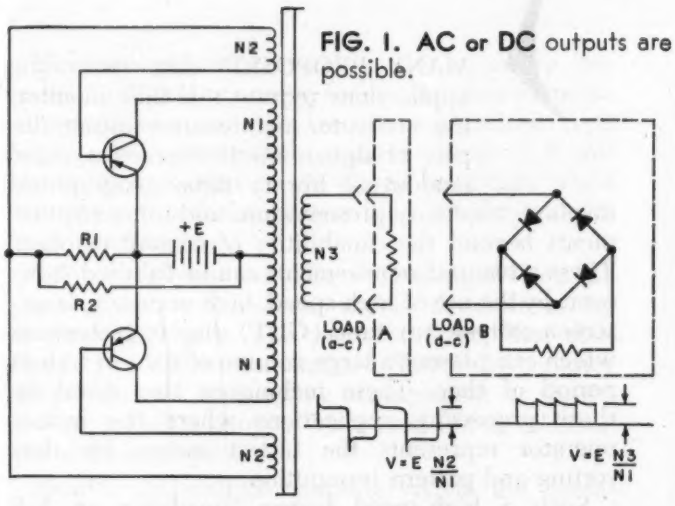


FIG. 1. AC or DC outputs are possible.

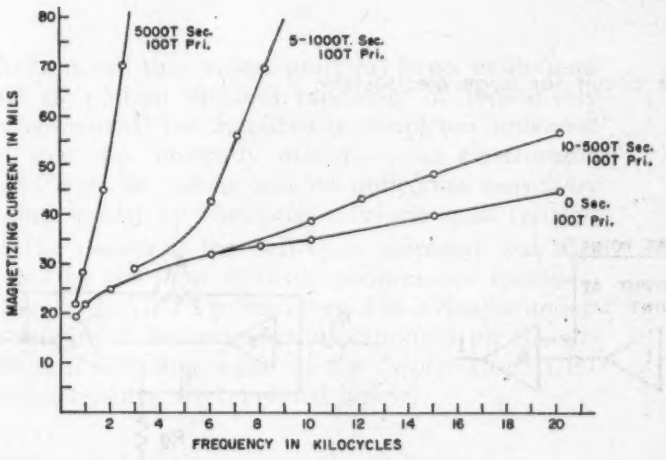


FIG. 2. EFFECT of excessive secondary turns.

Basic design of either dc-dc or dc-ac converters can be resolved to the circuit of the simple magnetic coupled multivibrator (Fig. 1). It is used in most cases to replace the vibrator power supply which converts dc to ac; or, when the output is rectified, to convert dc to dc usually with the output at the higher voltage.

The transistors in Fig. 1 operate only as switches, serving the same function as the contacts of a mechanical vibrator. The energy to operate the transistors as switches is supplied by feedback windings N_2 to the base of the transistors. The iron core is driven to positive and negative saturation on alternate half cycles, inducing in all windings an alternating square wave voltage. This square wave may be delivered to the load directly (Load A) or may be rectified (full wave) at a voltage higher or lower than the battery voltage, depending upon the turns ratio N_3/N_1 (Load B).

The voltage spike on the leading edge of each pulse is produced by the inductive kick from a switch opening an inductive circuit, in this case a transistor switching OFF. This voltage pulse from one transistor is the impulse which turns the other transistor ON, hence it serves a useful purpose. If this pulse is too high, however, the transistors may be damaged. It can be minimized by using magnetic materials which have a rectangular hysteresis loop such that at saturation the windings exhibit low inductance and little kickback. Because of transistor gain, there is usually no problem in having the kickback too small.

Transistor Selection

The maximum voltage rating of the transistor must be at least twice the battery voltage. When one transistor is conducting, the other must block the battery potential plus the induced battery voltage in the primary winding plus the transient spike which at light loads may be as high as the battery voltage.

Most transistors can safely switch up to 8 times their Class A power rating. Accordingly each transistor with a 2 watt class A rating can switch 16 watts, so that two transistors can handle 32 watts. If an efficiency of 80% is assumed, 25.6 watts will be available at the output.

Because of junction heating, the maximum collector current, which is independent of the supply voltage, sets a limit on the output of any transistor. To get maximum efficiency from a power converter under load, the transistors should be operated at their maximum voltage rating. Assuming that the circuit losses (core, copper and transistor losses) are fixed, the efficiency under load is increased with increased supply voltage. The use of transistors with high gain also improves efficiency since the driving power fed back to the base must be supplied from the source through windings N_2. The current-limiting resistor R_1 value should be selected to keep the I^2R loss small, hence the N_1/N_2 should be as high as possible, yet allow N_2 to be adequate to provide sufficient voltage and current to saturate the transistor at high collector currents.

The frequency cutoff characteristics of the transistor must be high compared to the actual switching frequency in order to minimize junction heating between saturation and cut off. The frequency cut off characteristic of the transistor should be at least ten times the frequency of the multivibrator.

Magnetic Core Characteristics

Square hyteresis loop core materials are recommended to assure fast switching times, low core losses, and frequency stability. Applications using frequencies in excess of 1600 cps should be designed using 1 mil tape wound core materials; at 1 kc, 1 or 2 mil; 200 cps, 2 or 4 mil; and at 60 cps or below, 4 or 6 mils will suffice.

The choice of core material can be simplified by considering only two kinds of material: (a) 50% NiFe grain oriented, such as Orthonol®[1]; and (b) 79% NiFe non-oriented, such as Hy Mu 80®[2]. Orthonol has a very high maximum flux density with low losses, whereas Hy Mu 80 has about one-half the maximum flux density of Orthonol but only about one-tenth the losses of Orthonol. To the converter designer, this means that in most power applications where a given voltage and frequency are required, the best choice is Orthonol. Choosing the high flux density material means that less iron and copper are required, with maximum miniaturization and high efficiency. The efficiency is high because the core losses are small compared to the output power which may be many watts. High efficiencies are also attained at high audio frequencies because the core size is decreased with an increase in frequency, hence the increased core losses are offset by the reduction in core volume. On the other hand, when the design calls for a high voltage at low power levels such as a dc supply for photo tubes, Geiger tubes and the like, the material having the lowest core losses, such as Hy Mu 80, should be used.

For proper operation of a magnetic-coupled multivibrator, where switching is initiated by core saturation, there must be a significant change in the core impedance as it proceeds into saturation. An adequate number of turns must be used on the primary to produce this change in impedance. In Fig. 1 the number of primary windings N_1 should be 10 or greater and N_2 should be 5 turns or more.

Too many secondary turns, particularly in circuits operated at 3 kc or above, result in excessive magnetizing current resulting from the flow of charging current into secondary winding capacitance (Fig. 2).

(From 14-page report which includes examples of Power Converter and DC-DC High Voltage Supply design to specific parameters, by Magnetics, Inc., Butler, Pa.)

®[1] Trademark, Magnetics Inc.
®[2] Trademark, The Carpenter Steel Co.

FOR THIS LITERATURE CIRCLE 103 ON READER-SERVICE CARD

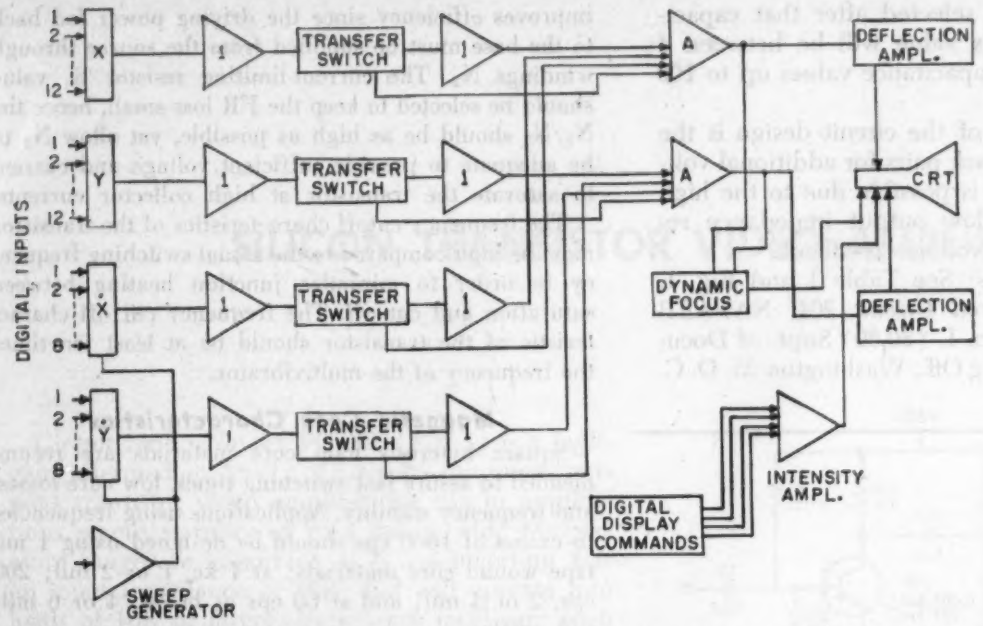


FIG. 1. BLOCK DIAGRAM, High-Speed, X-Y plotter circuit for large electrostatic cathode ray tube.

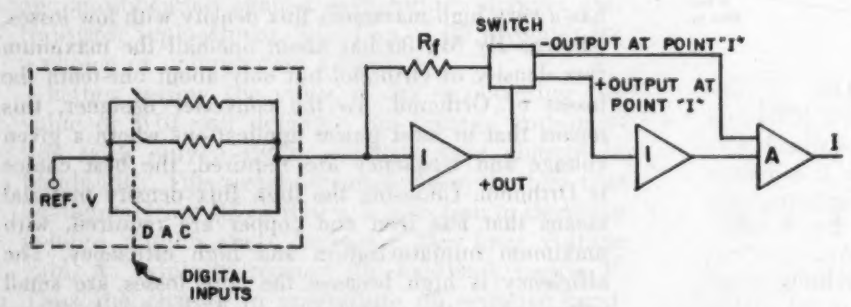


FIG. 2. DIGITAL-to-Analog Converter is teamed with operational amplifiers.

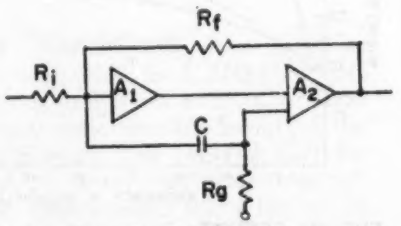


FIG. 3. OPERATIONAL Amplifier uses unique ac-dc coupling.

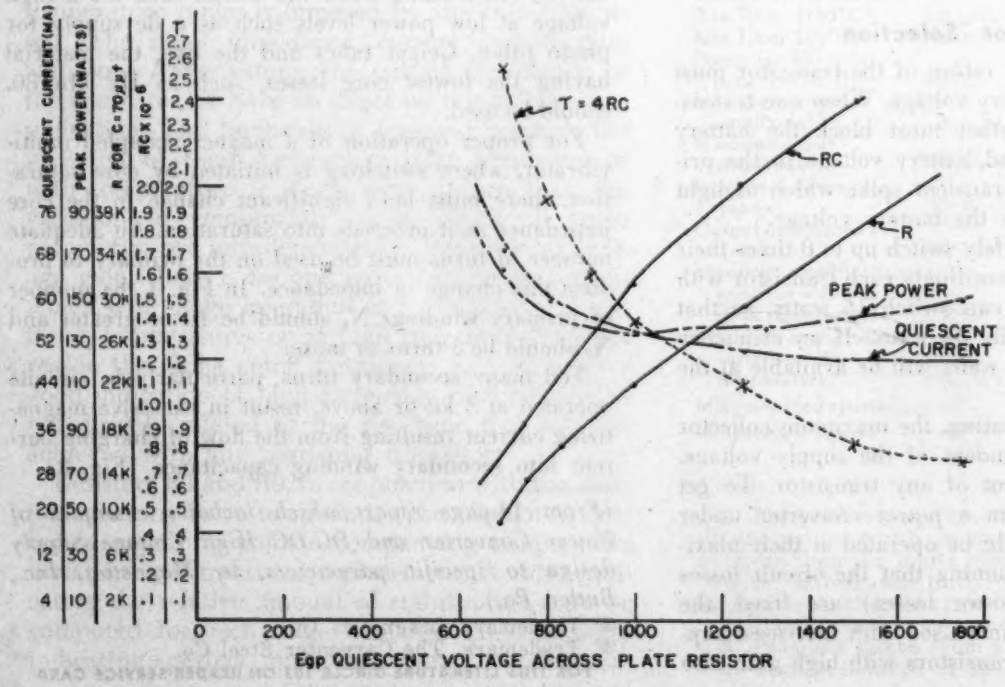


FIG. 4. PARAMETERS required to swing 4-65A tube plates are shown in graphical form.

HIGH-SPEED, LARGE-SCREEN CA

MANY PROPOSED data processing applications require real-time monitoring, computer maintenance testing, display of alphanumeric characters, rapid readout of library data, geographical displays, trajectory presentations and other requirements beyond the capabilities of current displays. These advanced requirements can be fulfilled, however, by the use of high-speed, high-accuracy, large-screen cathode ray tube (CRT) display techniques which can present a large volume of data in a short period of time. These techniques also speed up those processing applications where the human operator represents the fastest means for data sorting and pattern recognition.

Such a high-speed system, involving an X-Y plotter display which can locate any position on the face of a 16" cathode ray tube, settling to one-half spot diameter within 6 μsec, now under development by Melpar, is the subject of this article. [1]

This display system, using new electrostatically deflected CRT's with high resolution, higher deflection sensitivity, and provisions for dynamic focusing, utilizes digital input positioning data consisting of 12 binary bits plus a sign bit for X and 12 binary bits plus a sign bit for Y. Display intensity is also controlled by binary input data.

The new electrostatic CRT's also have the advantage of not being limited by driving power requirements for high writing speeds (as are the electromagnetic deflected CRT's), resulting in a reduction of power-supply and driving-amplifier requirements of an order of magnitude or more.

Modular construction is used throughout the system. The basic building blocks used to configure the X-Y plotter are shown in Fig. 1.

A semiconductor type digital-to-analog converter (DAC) converts digital input data to an analog current which is summed in an operational amplifier node (Fig. 2). The response of the converter-operational amplifier combination is less than 1.2 μsec to 0.05% accuracy.

[1] 16" Triode Gun cathode ray tubes are manufactured both by Du Mont Labs., and by General Electric.

CATHODE RAY TUBE DISPLAYS NOW PRACTICABLE

C. B. CHRISTIE
B. G. TREGUB
Melpar, Inc.

Electronic transfer switches are necessary because the digital-to-analog converters have unipolar outputs. These switches are of the transistor type having an approximately constant drop of 5 mv across the transistor in the closed condition, while having an impedance greater than 10^8 ohms in the open condition.

The operational amplifiers have open loop dc gains of about 5 million; usable dynamic swing of over ±100 volts. The operational amplifier consists of two differential stages followed by a rather unique dc and ac coupling arrangement as shown in Fig. 3, and is chopper stabilized for dc stability and drift free operation.

Due to this unique coupling system the operational amplifier appears to have only one time constant for high frequencies and is therefore guaranteed stable. Without this coupling capacitor the amplifier would roll-off at 12 db/octave and would, therefore be unstable. The coupling capacitor acts as a shunt by-passing the front end of the amplifier for high frequencies, therefore giving an execptionally good rise time. The settling time of the amplifier is 1.0 μs to 0.1% of the final value.

Deflection Amplifier Design is Display Breakthrough

The deflection amplifier is considered a major advance in the state of CRT display art. This amplifier can be used with any electrostatic CRT whose push-pull voltage gradient across the deflection plates does not exceed 2400 V for full scale deflection. Full-screen spot positioning can be accomplished to within one spot diameter in 3.5 μsec, achieving perhaps the fastest large screen display ever generated to date. Because the amplifier is direct coupled and chopper stabilized with an open loop gain of over one million, it is not repetition-rate sensitive and its long term drift referred to the input is less than 25 millivolts.

This deflection amplifier is capable of driving 16″ and 19″ electrostatic CRT's presently in production and thus makes practical large, easily-read dot or pattern displays randomly or repetitively programmed. The amplifier is completely universal in that any presently manufactured electrostatic CRT can be driven and its deflection sensitivity compensated by changing only one gain resistor.

The design of the deflection amplifier was dictated by the most difficult performance specifications of the CRT's to be driven. For a clearer understanding of the requirements imposed on the deflection amplifier some of the "worst case" CRT characteristics are tabulated below:

Screen diameter	=	16	inches
Deflection sensitivity	=	150	volts/inch
Dot size within usable scan area	=	30	mils
Writing speed	=	0.5	inches/μs
Deflection plate capacitance	=	40	μμf
Frame rate	=	30	frames/sec
Grid drive (max)	=	65	volts
Max ambient light	=	25	lumens/ft²
Dynamic focus correction (horizontal)	=	450	volts max.
Dynamic focus correction (vertical)	=	450	volts max.

A pushpull deflection amplifier must swing ±1200 volts, since it requires approximately 2400 volts differential between the deflection plates to deflect the electron beam across the full diameter of the screen. In this application the system requirement was to position the electron beam to within ½ spot diameter in 6 μsec. Of this time 3.5 μsec was alloted for the deflection amplifier settling time of which 2 μsec was alloted for the deflection plate driving stage. Operational amplifier feedback provides high degrees of accuracy and gain linearity in the overall transfer function.

To handle the driving and quiescent power required in this application a pair of 4-65A transmitting tubes were chosen as the final output stage. To aid in the design a set of curves were plotted showing the parameters required to swing the plate voltage plus or minus 600 volts in 2 μsec (Fig. 4).

The curves were calculated based on the formula

$$(Ebb - Eqp)\ (1 - e - t/RC) = E \text{ swing} \quad (1)$$

Where: RC is the time constant in the plate
Ebb is the supply voltage
Eqp is the quiescent plate voltage across plate resistor
t is the time from grid cut off

Imposing the design criteria, the formula is reduced to—

$$RC = \frac{-2 \times 10^{-6}}{\log_e\ (1 - 600/Eqp)} \quad (2)$$

From this equation a plot of T = t/RC can be plotted as a function of Eqp. Then if a value of $C_t = 70$ μμf is assumed[2], a plot of R vs Eqp may be plotted, and from obvious considerations plots of quiescent current, quiescent power in the plate resistor, and peak power in the plate resistor may be calculated. From these curves the driver stage (Fig. 5) of the amplifier is designed.

[2] 30 μμf is allotted for wiring in addition to plate capacitance of the cathode ray tube.

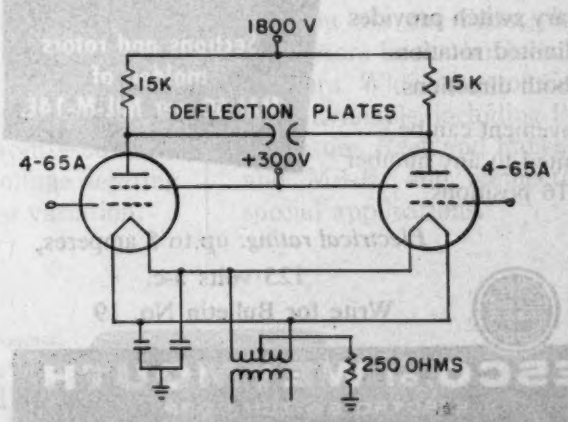
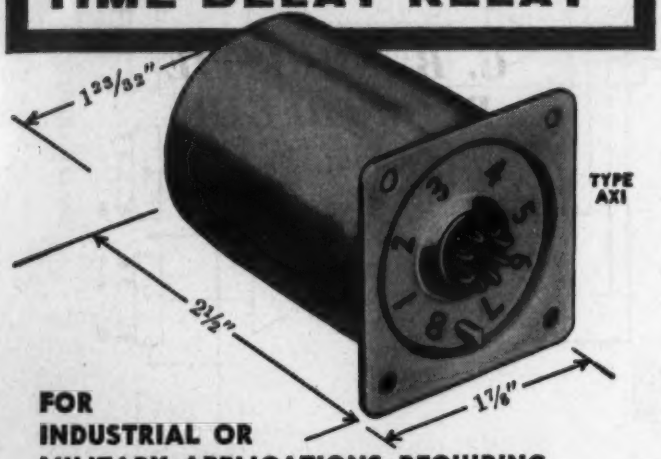


FIG. 5. DRIVER STAGE—Deflection Amplifier

EAGLE "Mil-Spec" Precision TIME DELAY RELAY



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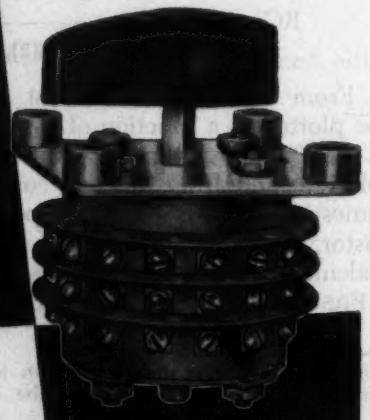

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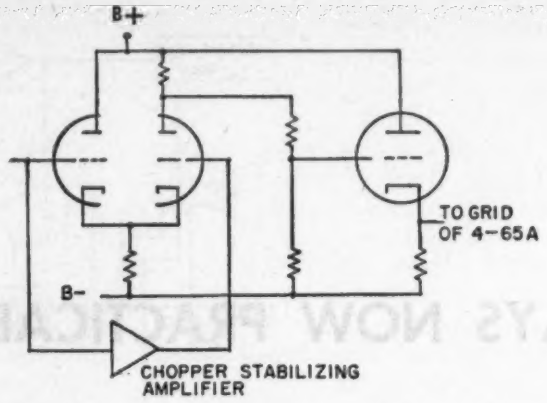

FIG. 6. VOLTAGE DRIVE section of deflection amplifier.

The amplifier driver stage when tested with a step function at the control grid resulted in a plate swing of 600 volts per plate in 1.5 μsec.

Design of the voltage amplifier to drive the output stages involves design techniques of dc coupling, chopper stabilization, linear operation and large voltage transients, but will not be discussed here because of space considerations. A sample configuration of the voltage drive stage is shown in Fig. 6.

Transient response of the completed feedback driver amplifier is shown in Fig. 7, derived from a CRT test photo. From this photo the settling time is seen to be approximately 3½ μsec.

Fig. 8 shows the completed chassis of both the x and y deflection amplifiers.

The overall spot positioning time of the completed system was measured to be 5 μs to ½ spot diameter.

In drawing lines of various slopes for display, digital logic circuitry is utilized to adjust the rate of current flow in an integrator type circuit the output of which furnishes the reference voltage for the x and y slope digital-to-analog converters.

Intensity Amplifier Design

The intensity amplifier is a digitally programmed direct coupled transistor amplifier used to drive the grid of a CRT to control brightness of information display on the tube face (Z-axis modulation). The amplifier is characterized by a 100 nano-second rise time, a 65 volt pulse amplitude and four pairs of inputs individually and remotely adjustable for vernier amplitude control.

Each input is gated directly by digital logic

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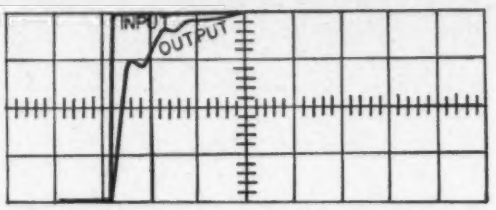

FIG. 7. TRANSIENT response of deflection amplifier. Vertical scale: Output wave form, 300v/square. Input wave form, 25v/square. Horizontal squares each represent 1 μsec.

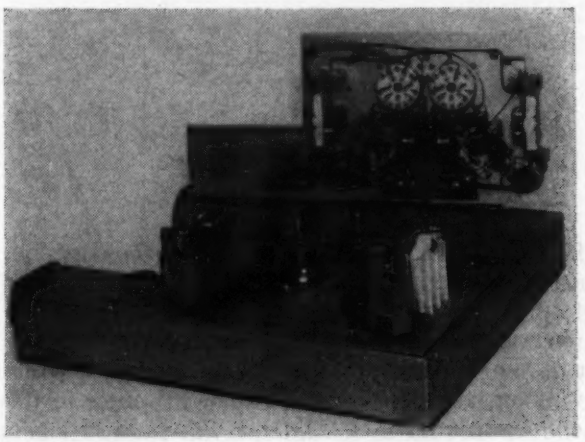

FIG. 8. "X" AND "Y" deflection amplifiers for 16" Electrostatic CRT.

levels of zero and minus eight volts. One input of each pair provides an output level approximately one and one-half times the magnitude of the other input. This feature is useful where expanded scale displays are used, requiring faster writing speeds and greater grid drive. An individual gain control is remotely provided at the operator location for each pair of inputs. This allows four adjustable contrast levels to be programmed during a display, permitting multiple pattern overlays of various intensities and increasing the speed of pattern recognition. The operator can manually blank any particular pattern or can increase its brightness level above any other displayed information.

Dynamic Focusing Sub-System

The dynamic focusing system provides a correction voltage to compensate for deflection defocusing of the beam in an electrostatic CRT as it moves toward the edge of the tube. Any shape focus correction curve specified by the manufacturer can be duplicated with this system provided the maximum value of the correction voltage does not exceed 600 volts. This makes possible increased resolution and associated accuracy in the reading of data displayed at high speed on large electrostatic CRT's.

This correction voltage may be direct coupled to the focus grid of the CRT regardless of the dc potential appearing there. The disadvantages of RF

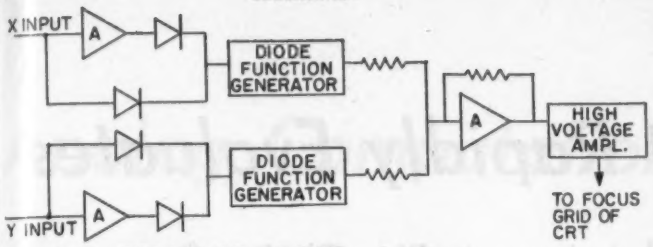

FIG. 9. DYNAMIC FOCUS subsystem.

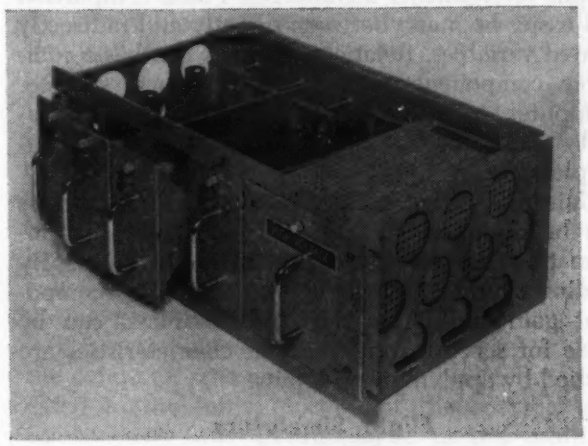

FIG. 10. DYNAMIC FOCUSING sub-system. Four operational amplifiers and high voltage coupling amplifier shown in standard module housing.

or capacitive coupling (noise and radiation problems with RF, repetition rate problems with capacitive coupling) are not present in the system.

The X- and Y-axis correction curves are individually generated by resistor-diode matrices and operational amplifiers and are summed by a third operational amplifier (see Figs. 9 & 10). This latter amplifier can be adjusted to control the amount of focus correction actually applied to the focus grid. Its output drives a high voltage coupling amplifier which is directly coupled to the focus grid.

Full scale focusing voltage can be applied in 3.5 μsec maximum. Although the input waveforms are usually the same as those fed to the deflection amplifiers, variations of circuitry exist to allow extreme flexibility in adapting this unit to operate under almost any conditions encountered in present CRT's.

This same technique can be used to provide dynamic astigmatism control for even further increased resolution on large CRT's. Tubes employing this feature are presently in the design stage and as the trend toward large display tubes increases, these new tubes employing tetrode gun designs and providing dynamic astigmatism control will undoubtedly come into wide use. Inquiries regarding specific applications of the techniques and equipment discussed will be welcomed by the *Special Products Dept., Melpar, Inc., 3000 Arlington Blvd., Falls Church, Va.*

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Graphic Readout Rapidly Evaluates An

DONALD E. PIERCE, Brush Instruments Div., Clevite, Corp.

FIG. 1. MULTI-CHANNEL direct writing oscillographs provide instant data on analog computer reaction. Here, a computer problem is monitored and pertinent notes made on the chart paper.

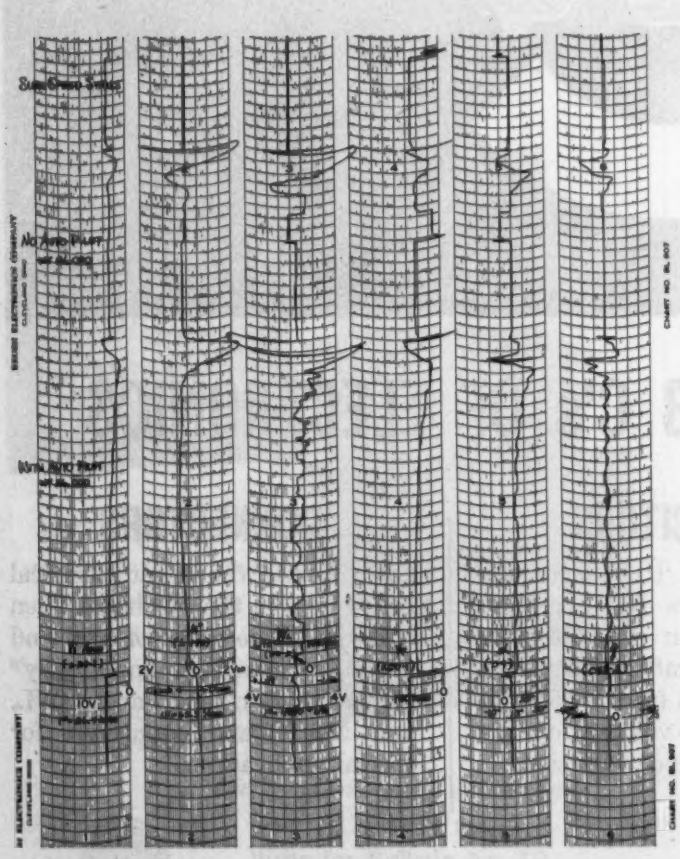


FIG. 2. FLIGHT SIMULATOR computer operation is constantly recorded during alignment and test out. Three linear and three angular velocities are recorded simultaneously on this chart to monitor operation of a single-seat jet aircraft simulator.

GRAPHIC READOUT of analog computers is a simple way to obtain a realistic picture of computer operation. Data records, obtained with multi-channel direct writing recorders, can be studied and prepared, first to determine whether a computer is functioning properly to produce accurate results; and second to evaluate problem solutions.

Oscillographs are used to trace problems through all stages of computation. Records are retained for study and interpretation, and for comparison of results obtained at different stages of development or operation.

Problems of the type assigned to analog computers are continuous and dynamic in nature, and are most accurately represented in continuous and dynamic terms. Oscillographic traces represent a true expression of continuity and are exactly allied to analog computer operation (Fig. 1).

Tests can be performed on computers such as those used in industrial control problems, aircraft flight control and simulation design, navigation, fire direction control, and in solving problems of space flight and environment.

Advantages of Graphic Readout

Although steady state conditions in a computer can be checked with a digital voltmeter, a dynamic check, made against time, requires the use of continuous and instantaneous metering. With a direct writing oscillograph monitoring the output of a computer, trial parameters can be inserted and their effect on performance tested instantly.

During the running of a problem, the direct writing oscillograph provides continuous monitoring. The records obtained are retained and compared with those of previous runs to determine consistency, improvement in performance or faulty operation. In multiple runs involving different parameters, a trend can be followed to determine which combinations of parameters afford the best results.

Since all records are made simultaneously on a single time base, no juggling of time reference marks between records is necessary. Additional advantages are gained by having immediate readability of data, flexibility, and sufficient room to record pertinent notes on the trace itself. Oscillograph records obtained are permanent and can be used or reproduced for reports.

Oscillograph Records Used in Test and Design

In testing computers, simultaneous recordings obtained on multi-channel direct writing oscillographs offer further advantages. Phase comparison can easily be made between directly and indirectly related variables. Relationships between basic computer components can be isolated and studied. Computer resolution, backlash, and transient instability can also be identified quickly in oscillographic traces.

Gain and phase shifts for computer servo loops can be designed quickly and easily by using information derived from the recorder chart. By feeding synthetic inputs to the computer, component gain and phase shift measurements can be made for servo loops. Transient characteristics are studied by applying step inputs.

Flight Simulators

Aircraft become increasingly more complex as greater demands on flight performance are made. Complexity of design is directly reflected in flight simulators and in the test and evaluation of these simulators. Multi-channel direct writing oscillographs expedite the complex testing phase. Use of oscillographs reduces test time considerably by providing accurate readable performance data rapidly.

The prime objective in building a flight simulator is to synthetically activate aircraft instruments located in a flight trainer. The instruments are activated as a result of the student pilot's reactions. To be most effective, the dynamic response of these instruments must accurately duplicate the characteristics of the aircraft simulated. Since in actual flight instruments follow definite relationships, these relationships can be duplicated with the use of analog computers.

The analog computer is the basic part of a flight simulator. The simulator computer must solve equations of aircraft aerodynamic motion representing six degrees of freedom—three linear velocities and three angular velocities. The equations for altitude, engine performance, attitude with respect to earth, and the aircraft's airstream characteristics must also be solved in order to accurately compute the aircraft's motion in space. The outputs of these computers are used to synthetically activate the simulator flight instruments. With the loop closed (pilot, to computer, to instruments, to pilot) effective and realistic training is given to student pilots without the use of actual aircraft.

Monitored Information

The multi-channel recorder chart shown in Fig. 2 inludes six parameters recorded during simulation

s Analog Computations

of a slow speed stall to test the flight simulator computer. Before any characteristics on the flight simulator can be tested, however, the computer itself must function properly.

The parameters monitored include: airspeed (V_I), rate of climb (h), aerodynamic lift (W_L), true airspeed (V_T), angle of attack (α), and pitching velocity about the body axis (q). This phase of test operation was conducted on the computer by feeding in the proper voltages to simulate the voltages which would come from the simulator during performance.

The aerodynamic lift, (W_L, Fig. 2), portion of the computer was not functioning properly as indicated in the initial portion of the oscillographic trace. There was an unbalance in the computer which caused the system to oscillate. This unbalance is reflected in all the other parameters. Deviation from expected performance was recorded immediately and an adjustment made.

In the second portion of the performance curve the computer is shown to function properly. The record of the deviation, its analysis and the adjustment to correct the deviation required only a few minutes. This was made possible because performance could be monitored so rapidly on the direct writing recorder.

Operation and Quality Tests

One reservation is made in evaluating the effectiveness of on-the-ground pilot training; the instrument indications and response to control movement must be realistic. Two areas of testing evolve from the process of testing the simulator for realism. First, the computers must be checked to insure accurate solutions to the equations; all solutions should be free from limitations and inaccuracies imposed by the computer components. Second, the "flying qualities" of the simulator must be matched to the characteristics of the aircraft simulated. Brush multi-channel oscillographs are used effectively in both areas of testing.

Bell Aircraft Landing System

Direct writing multi-channel recorders continuously monitor computers which control blind landings of huge jet aircraft. From the moment the plane comes within range of the airfield control system to the time it comes to a complete stop, the plane is guided by the computer. The computer was developed by Bell Aircraft's Avionics Division in conjunction with Boeing Aircraft (Fig. 3).

Graphic recordings of guidance and control systems such as the Bell system yield an immediate record of operation and permit monitoring of important parameters which must be kept within rigid limits.

Throughout the entire landing maneuver, despite zero-zero conditions, operators keep a continuous visual check on the guided plane's path by means of Brush direct writing oscillographs, integrated with the system. A constant check is maintained on the equipment's correct operation, and a permanent record of the landing (Fig. 4) is made available.

Any deviation or failure in the control of any of the parameters in aircraft landing could result in the loss of many lives and millions of dollars in damage. Parameters such as altitude, altitude error, pitch command, lateral error, lateral command and range are constantly checked. Any deviation from a smooth landing can be detected immediately and corrective action taken. Smooth performance is ensured. This results in increased capacity in traffic handling and continued operation even with zero visibility.

Input Transducers

To obtain accurate computer data, consideration must be given to the recording device, and to the source and method of obtaining recorder input signals. Assuming that a recorder with the required accuracy and response is available, emphasis can be placed on obtaining suitable input signals.

In an analog computer variables are represented by either a voltage or a shaft position. Where a voltage proportional to a shaft position is required, the proper transducer, such as a potentiometer, must be used on shafts to produce the voltage.

Once a voltage is obtained for the recorder input the signal can be connected to the input amplifier of the recorder. If the signal is d-c, it can be used with a d-c amplifier to drive a recorder pen; if the signal is a-c a demodulator circuit must be used to convert the signal to d-c. No phase shift or attentuation can be inserted in changing an a-c signal into d-c or the signal trace will be in error.

Special Requirements

In general, the voltage output from a computer is in the order of one volt for full scale deflection of the recording pen. This requires a stable d-c amplifier of medium sensitivity together with the oscillograph. Some of the requirements special to computer applications include: (a) Stability-with no shift of reference line in any mode of operation; (b) highly accurate multistep attentuation; (c) a wide range of chart speeds to permit optimum resolution of any signal regardless of frequency; (d) electrical control of chart speeds to permit starting, stopping, holding and instantaneous changes from the computer proper, and (e) pen position controls which permit full scale display of unipolarity signals with either margin used as a reference.

FOR MORE INFORMATION CIRCLE 105 ON READER-SERVICE CARD

FIG. 3. **EQUIPMENT** for controlling automatically the landing of huge high speed aircraft is housed in this trailer. Developed by Bell Aircraft, the equipment includes a direct writing recorder which monitors constantly the parameters which must be kept within close limits to ensure a safe landing.

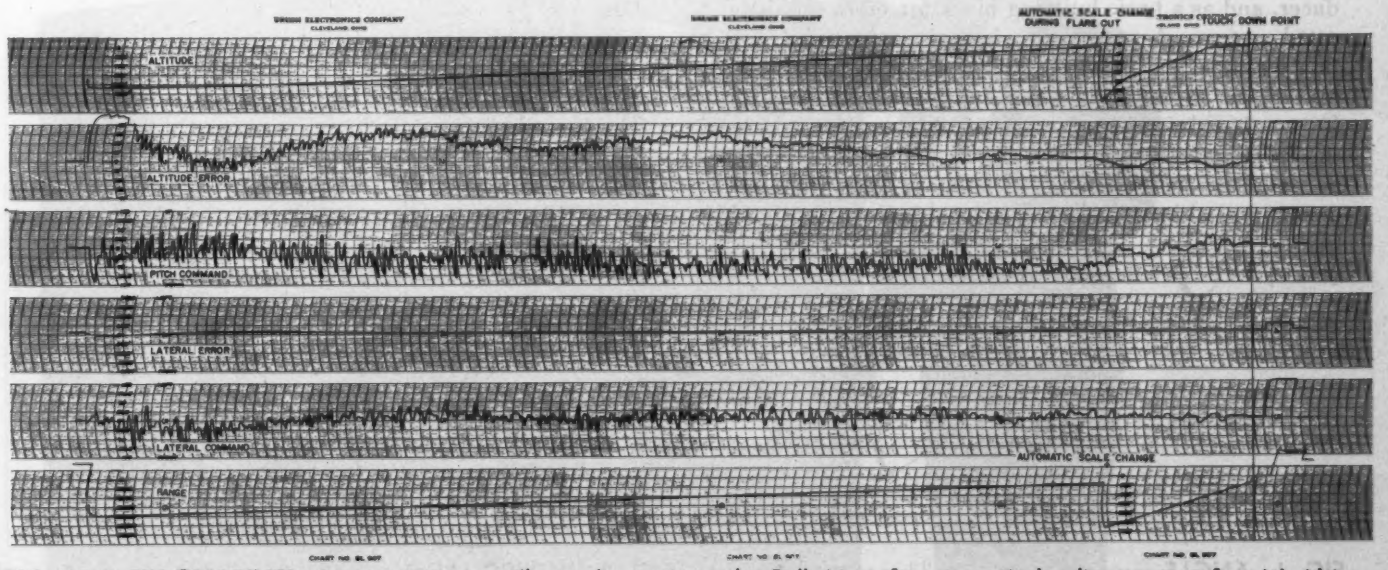


FIG. 4. **A SIX-CHANNEL** direct writing oscillograph monitors the Bell Aircraft automatic landing system for: (1) Altitude, (2) altitude error, (3) pitch command, (4) lateral error, (5) lateral command, (6) and range.

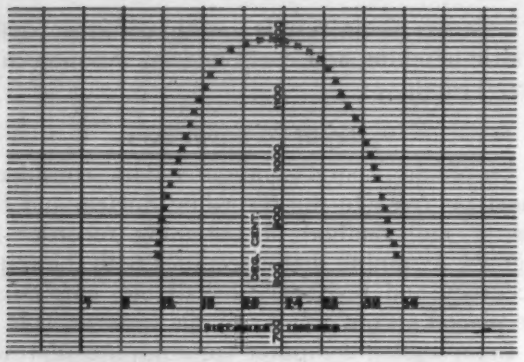
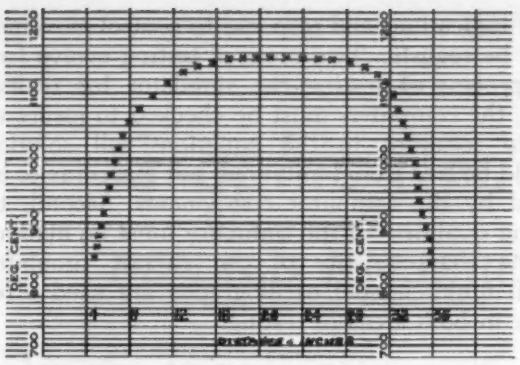


FIG. 1. CONVENTIONAL Furnace (left) without power compensation provides a bulging temperature profile in the diffusion zone. Pitt Precision Diffusion Furnace (right) with adjustable power input to different sections of heating zone, gives long profile flat to ±1°C.



New Diffusion Furnace Features Wide Temperature Profile

The temperature profile of a diffusion furnace is a principal factor in determining yield in production of diffused semiconductors. Conventional furnaces having no power compensation have a bulging temperature profile (Fig. 1—left) in which the constant temperature zone is limited. A flat temperature profile (right) as found in the Pitt Precision Furnace means a larger usable work zone, providing better control of junction spacing, fewer rejects, and higher yield.

The Pitt Precision Model D12F12-6 two-zone Diffusion Furnace (Fig. 2) provides a low temperature source zone 4″ long maintained at 1000°C and a high temperature diffusion zone 10″ long maintained at 1200°C. An alumina thermocouple well is provided at the center of each zone for insertion of suitable thermocouples for temperature control. The muffle is of high purity alumina with 2″ I.D. and 48″ long.

Furnaces can be supplied by Pitt Precision Products, Inc., 261 Madison Ave., New York 16, N.Y., to meet almost any requirement in various temperature ranges from 100°C to 1600°C, with muffles 1″ to 10″ I.D., one-half foot to several feet in length, rectangular or circular in shape. Furnace designs which function under either oxidizing or reducing conditions are available; high-purity gas-tight muffles can be supplied where low oxygen content and purity are important in the furnace atmosphere.

FIG. 2. TWO ZONE Diffusion Furnace features longer work zones in which temperature can be maintained uniform within ±1°C. Available for operating temperatures to 1600°C and with up to three continuous but independently controlled zones.

FOR MORE INFORMATION CIRCLE 106 ON READER-SERVICE CARD

A Universal Pressure Transducer

The TR2100 Force balance pressure transducer is designed to serve as a self-contained pressure transducer, and as a basic building block for more sophisticated systems. A noteworthy feature is the ability of this instrument to furnish a mechanical output, if required, as an input to other functional elements or for continued computations. Typical systems in which the force balance pressure transducers have been are as follows: true airspeed computers, Lox tanking computers, altimeters, barometric altitude controllers (BAC), jet engine duct control, central air data computers, pressure generating test sets and mach computers.

Theory of Operation

The force balance transducer consists of a pressure sensor, a servo and various output devices. The "heart" of the transducer is the extremely accurate pressure sensor. This unit is of universal design and readily adaptable to a number of configurations and ranges. Three basic configurations of the sensor will satisfy the previously mentioned applications and may be categorized to measure:

1) Individual pressures
2) The difference of two individual pressures, or
3) The ratio of two individual pressures.

The principle used in these configurations is the same in each case, i.e., the unknown pressure forces F_1 and F_2 are placed on a common point at 90° to each other. The angle (θ) the equilibrant assumes in restoring a balance of forces is a measure of the ratio of the forces (Fig. 1).

The geometrical relationship which prevails when

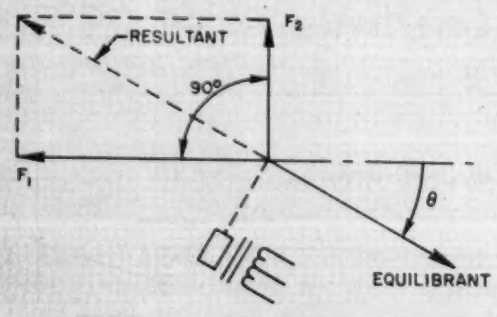


FIG. 1. ANGLE assumed by the equilibrant is a measure of the ratio of the two forces.

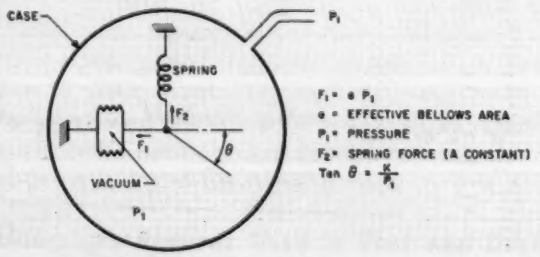


FIG. 2. INDIVIDUAL Pressures are measured against a vacuum.

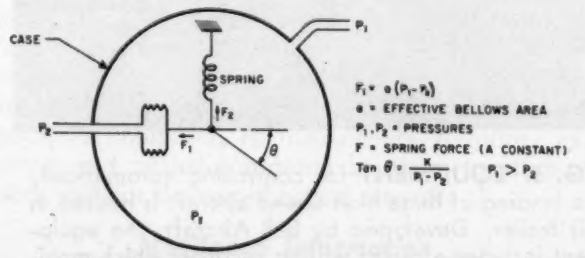


FIG. 3. DIFFERENCE between two pressures is measured against spring constant.

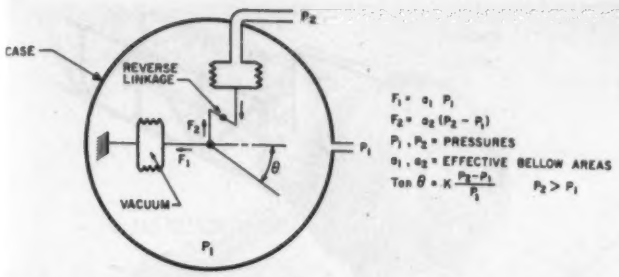


FIG. 4. CONFIGURATION for measuring the ratio of two individual pressures.

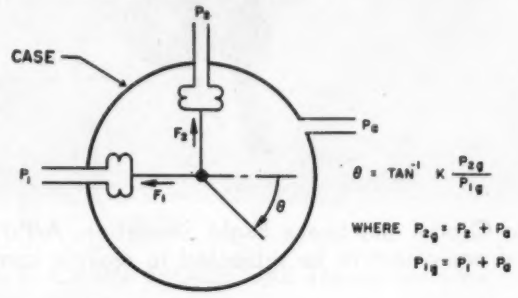


FIG. 5. RATIO of two gage pressures is provided by the above configuration.

equilibrium is established is: $\tan\theta = F_2/F_1$

It should be noted that the summation center is always restored to the same location, rendering the forces immune to variations due to capsule spring constants, effective area changes with position, etc.

This concept makes possible the replacement of either forces by a precision spring which, by virture of the invariant restoration, becomes a constant force. The relationship under these circumstances becomes

$$\tan\theta = KF,$$

a function of but a single force.

The three basic configurations are shown in Figures 2 through 5.

In applying this principle, it is necessary to detect any change in the balance of forces. This is accomplished by allowing the center of the forces to be free to move so that an error signal is generated by means of an electrical pickoff. The error signal is used to drive the equilibrant to the equilibrium position under servo control. At equilibrium the servo shaft position is proportional to θ. This shaft is used for positioning a variety of output devices.

A function generator is available for static pressure defect compensation when the transducer is used in the mach number configuration. For those applications, where linearization of the θ shaft with pressure, differential pressure or pressure ratio is required, an adjustable differential function generator may be placed in the feed back loop between the motor and the sensor equilibrant shaft. SMI offers either mechanical or electrical function generation (or linearization). For very precise applications, the functioning is adjustable to allow a certain amount of systematic error correction. A variety of combinations of output devices are available, such as potentiometers and synchro, two synchros, spring return-clutch-actuated potentiometer or synchro, rate generator, etc.—(*From 4-page Technical bulletin Type TR2100, Servomechanisms, Inc., 2500 Aviation Blvd., Hawthorne, Calif.*)

FOR THIS LITERATURE CIRCLE 107 ON READER-SERVICE CARD

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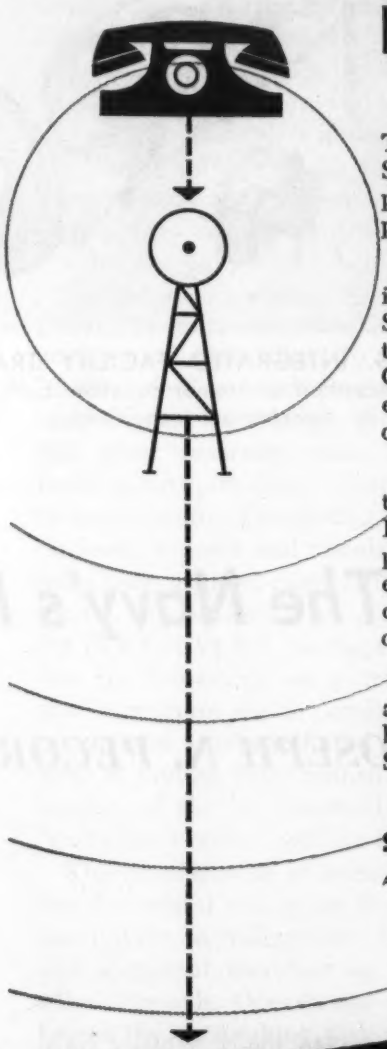

The U.S. Army Corps of Engineers is using Stromberg-Carlson—San Diego's new S-C 3000 High Speed Communications Printer to print 3000 words a minute from remote sources. The equipment can print out over great distances, using standard wire or radio links.

The S-C 3000 is compatible with most available data link systems, including the Collins Kineplex data transmission system and the Stromberg-Carlson Binary Data Link. Printing is accomplished through a unique combination of the Stromberg-Carlson CHARACTRON® shaped beam tube and Haloid Xerox Inc's., electrostatic printing process. The S-C 3000 prints without impact on untreated paper or lithographic masters.

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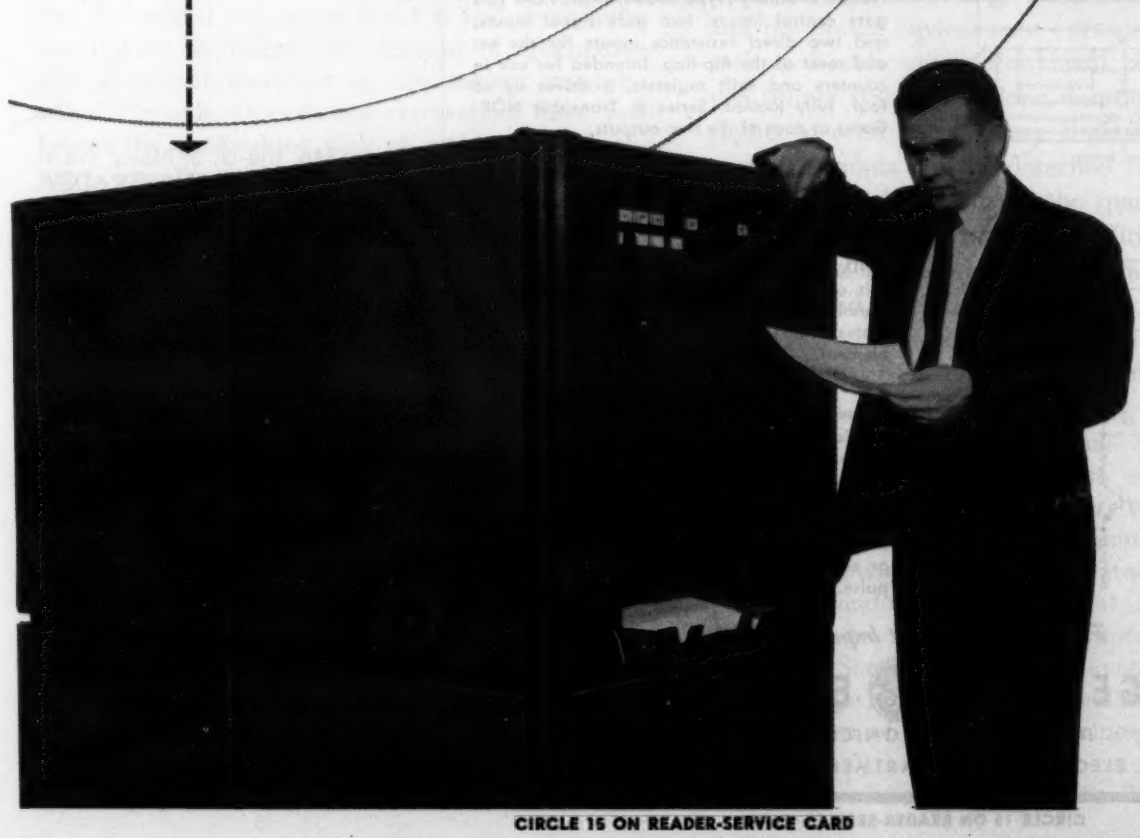

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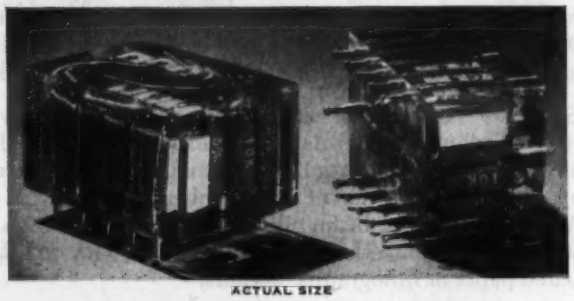
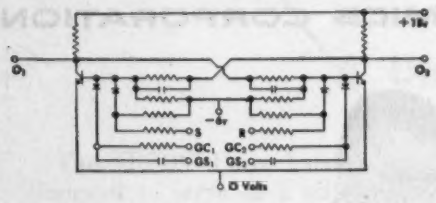
- **Rugged, uniform packaging**



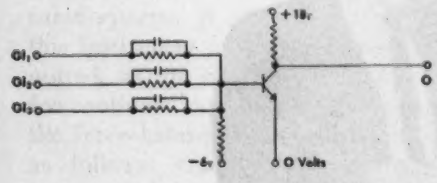
ACTUAL SIZE

Series M Transistor Logic Elements now provide maximum reliability and high frequency performance over an extended temperature range of −40 C to +125 C. Pre-designed for immediate use in breadboard, prototype or production equipment, these compatible logic modules find versatile defense applications in digital computer and data handling systems. Encapsulation in high-temperature epoxy material, semi-transparent for easy inspection of internal assembly, affords protection from extreme environmental conditions of humidity, shock and vibration. Metal feed-through sleeves improve mounting flexibility, while uniform packaging and terminal arrangement facilitate interconnection of modules.

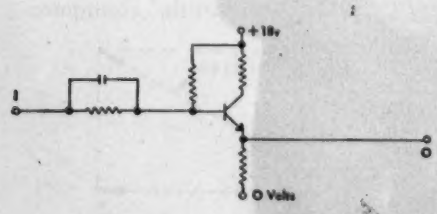
Reasonably priced and available for prompt delivery, General Electric Transistor Logic Elements are manufactured from thoroughly tested, quality components. These saturating and resistance-coupled modules are also offered in circuit and packaging variations, custom designed to meet specific engineering requirements.



Transistor Binary (Type M-264) **—provides two gate control inputs, two gate signal inputs, and two direct resistance inputs for the set and reset of the flip-flop. Intended for use in counters and shift registers, it drives up to four, fully loaded, Series M Transistor NOR-Gates at each of the two outputs.**



Transistor NOR-Gate (Type M-134) **—performs pulse inversion and logic functions OR and AND. Each of the two separate elements of this common emitter switch drives four additional, fully loaded, Series M Transistor NOR-Gates. Three inputs are furnished for each element.**



Transistor Emitter Follower (Type M-31-10) **— consists of two separate elements with individual input and output terminals. Both elements are capable of driving up to ten, fully loaded, Series M Transistor NOR-Gates. Applications are found in impedance transformation and in driving logic elements without inversion or significant degradation in the transmitted pulse.** 176-52

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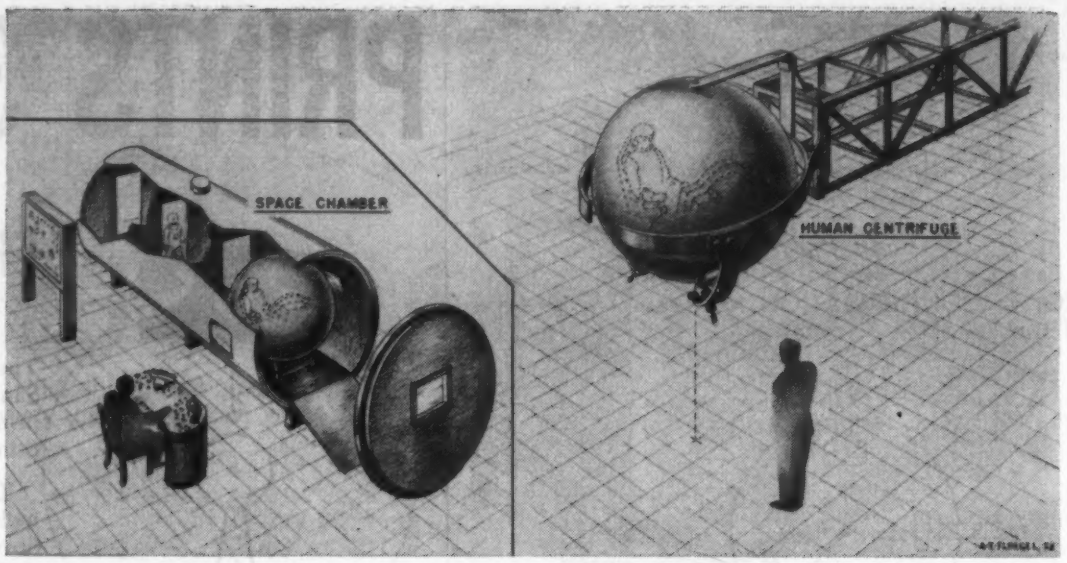

FIG. INTEGRATED FACILITY TRAINER for Orbital and Space Flight Simulation. Artist's conception of trainer to allow both crews and equipment to be subjected to realistic composite environment conditions.

The Navy's Role in Astronautical

JOSEPH N. PECORARO, Head, Equipment Research Division

Since 1946, the U. S. Naval Training Device Center (NAVTRADEVCEN) located at Port Washington, L. I., N. Y., has specialized in synthetic training devices and systems for the nation's air, surface, subsurface and land combat forces. For example, Operational Flight Trainers synthesize the complete flying environment in advanced jets with such realism that pilots often become "air-sick" during "flight." The Center's Rapid Decompression Chambers, Tank Turret Trainers, Subcalibre Mortar Trainers, Submarine, CIC and Radar Trainers, in every case synthesize environmental characteristics for the basic and advanced training of military personnel.

DEVELOPMENT of a manned space vehicle can be said to have started years ago when new theories of missile and satellite flight led to the first experimental rockets and probings of the outer reaches of the atmosphere. In fact, every test firing, even each disheartening missile "failure", has been one more step toward the day when a completed man-carrying space missile will stand poised at its gantry. Behind it will be an exhaustive series of appraisals, testings, evaluations, revisions and modifications. Each step in its development, each component which has been retested and proved in reaching for absolute reliability, will have contributed to an astronomical total cost in money and engineering skills.

However, building, testing and firing the vehicle is only part of the program. Providing the great bird with a firing site, ground support equipment, control and tracking equipment and skilled technicians to man facilities may cost even more than the missile itself. Without this elaborate ground support system, the missile would be a helpless, useless "white elephant."

Even with an adequate space vehicle and a

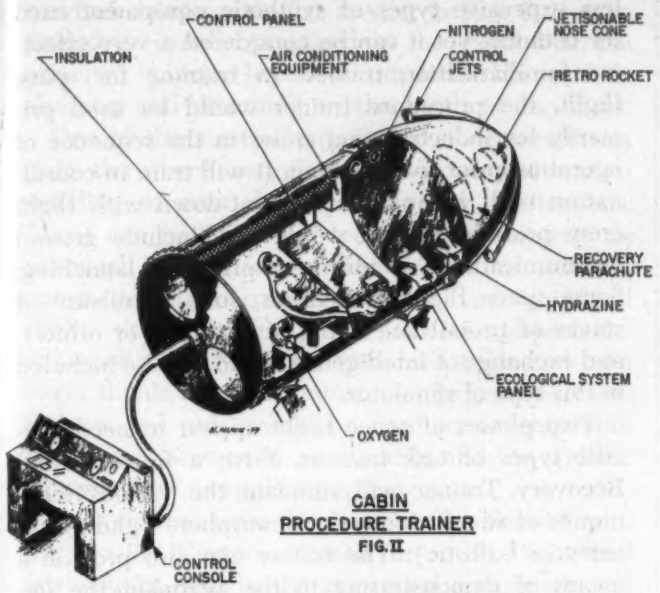

FIG. 2. CABIN PROCEDURE Trainer for crew indoctrination.

Training Devices

U.S. Naval Training Device Center

full ground support system, the problem is still only half solved. The next prime problem is the human manning of the vehicle for its brief journey into the wild and uncharted blue yonder. Man in space will be exposed to phenomena never experienced—or dreamed of, by humans before—he'll encounter violent extremes of heat and cold, complete release of gravity, acceleration and deceleration, fantastic velocities, violent forces (up to 32 times the force of gravity) high frequency noises, radiation, ionization, and exceedingly high pressures.

In order to survive and send back useful scientific data, the spaceman must be able to function almost normally, he must be able to adjust himself to his frightening new environment, he must be able to control his vehicle and maneuver his reentry into the earth's atmosphere.

Needless to say, without some prior adjustment to these conditions, man could not survive in space. Space training, then, must resolve the space machine—space man relationship, and the space—man relationship. It is one of the prime problems facing us today.

Synthetic Training Techniques

To NAVTRADEVCEN's more than 600 engineers, scientists, and psychologists, synthesizing the operating environment of military hardware means more than just duplicating equipment,—it involves computations of physical stress, size, weight, power requirements, and operating characteristics. From these computations emerge the means of simulating form and motion, and allowing the trainee to see, hear, and sense the scope of his technical or tactical responsibilities. With the revolutionary advent of the space age, the Center's training equipment researchers have focused their attention on the building of trainers and training systems for guided and ballistic missiles.

Simulator experience has enabled NAVTRADEVCEN in its early recognition of the military importance of space flight to undertake many local "in-the-house" research programs for extending our technological knowledge. It can readily be seen that great monetary sums will be required for building complex space weapon systems. In order to keep already skyrocketing costs at a more realistic level, trainers and simulators must be built to train both manned flight and ground support personnel at all levels at a much reduced cost. NAVTRADEVCEN has kept pace with this problem by embarking on a training equipment research program which parallels that of operational research of equipment and trends. This program aims at putting fully trained crews aboard and in support of the first manned missle that flies. No "shakedown cruise" will be made!

The development of training devices or simulators for orbital and space flight is still at an awkward stage. A voluminous amount of speculative and analytical literature on the subject must be sifted through. Operational researchers have just begun the painstaking task of making real hardware actually work. Significant in this respect is the fact that before the design of the operational hardware was complete, the National Astronautical Space Agency (NASA) found in NAVTRADEVCEN's Human Centrifuge device a useful dynamic simulator for the design study and evaluation of equipment. Even more important was the use of the Centrifuge for the training of the crew in the expected trajectory planned for the X-15 research orbital vehicle.

Now is time for new ideas in this dynamic new field! The very idea of providing simulators and trainers for space vehicles presents a stimulating challenge. Some worthwhile concepts have already been proposed, investigated and adjudged feasible. Trainer systems and equipment presently under consideration at NAVTRADEVCEN can be divided into the following two general categories: (1.) Integrated Ground System Facilities Simulators, and (2.) Equipment or Task Trainers.

The Integrated System Facility Simulators should be designed to allow personnel and equipment to be subjected to the composite environment created by the interaction of vehicle flight and space conditions. This will include a human centrifuge which will be the center of dynamic simulation of induced acceleration environment. In this phase of indoctrination, the crew's ability to control the simulator will be exercised when subjected to longitudinal and normal accelerations, and even vibration of the vehicle capsule. Targets and relative position simulators will be part of the vehicle simulator components. As currently envisioned, the low pressure indoctrination chamber will be available nearby for long or short-time flights. Changing atmospheric composition, heat, and cold can be included in this to simulate some of the operating experiences under which the crew will function, and to evaluate the efficiency of personnel. Fig. 1 is an artist's conception of the Ground Integrated System Facility Trainer. It includes the space chamber with simulated cockpit gondola and centrifuge arm. During a training program, personnel with full pressure suits can enter either the space chamber or the gondola in the chamber.

The gondola, which is the cockpit of the space vehicle, includes display and controls (flight instruments, control stick, throttle, etc.) and centrifuge motions which simulate vehicle response through a computer system supplied with signals generated by the crew in the centrifuge vehicle. In this simulator, such induced environments as accelerations (launching, vibrations and re-entry) and the hostile environment (pressure, oxygen and carbon dioxide elimination) will be combined in one trainer system. For long duration, or extended flights in orbit or planetary flights, the simulated cockpit gondola will be detached from the centrifuge and will be placed in the space chamber. In this facility, the control of air conditioning, pressurization, and the completed ecological system will be simulated. Specific tasks can be simulated outside the cockpit within the space chamber and reentry in the capsule cockpit can be practiced.

Since integrated system training facilities such as these will be limited because of the physical equipment and the huge cost involved, many *subsystem trainers* or *task trainers* will be required which can be utilized as components of the system facility discussed above. Task trainers of this type presently under consideration at NAVTRADEVCEN include: Procedure Simulators, Re-entry and Recovery Simulators, Space Navigational Simulators, Escape and Survival Simulators, and Space and Science of Astronautics Principle Demonstrators.

The procedure simulator (Fig. 2) is one of the

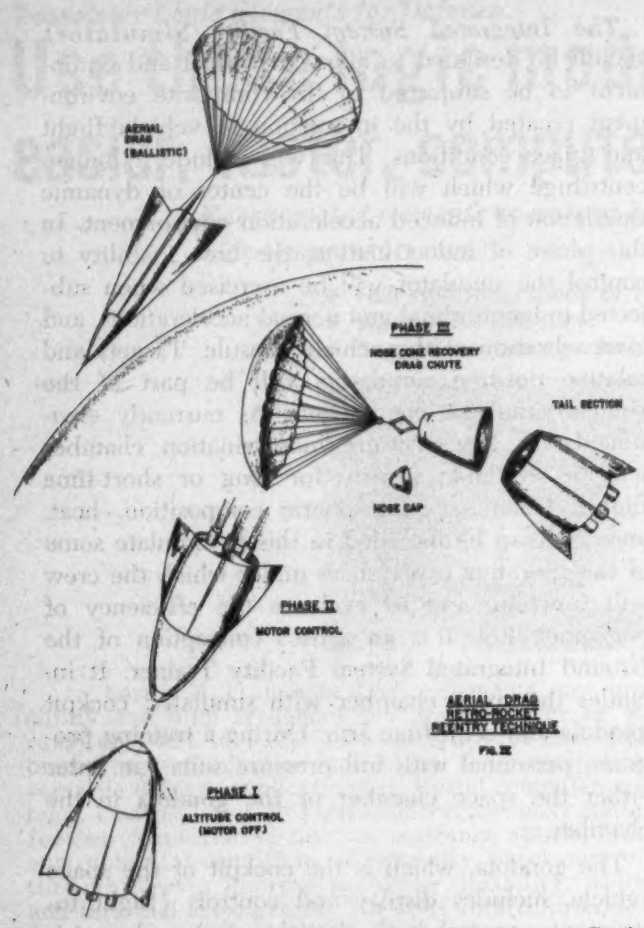

FIG. 3. AERIAL DRAG and Retro-Rocket Reentry Techniques.

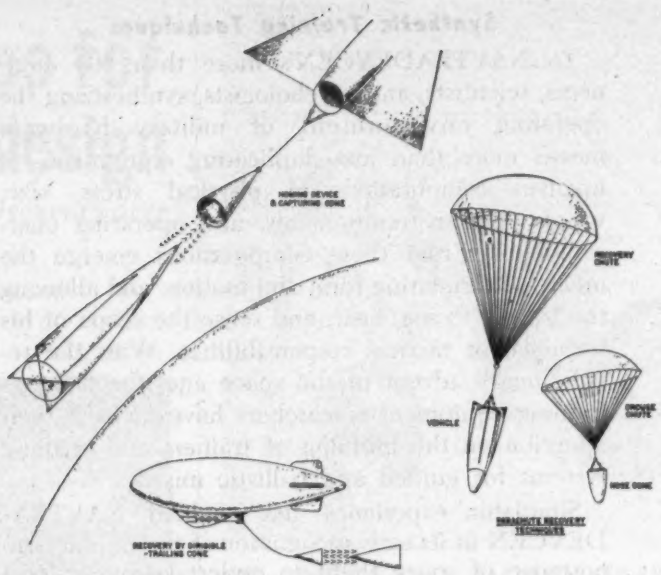

FIG. 4. AERIAL RECOVERY by several techniques are possible.

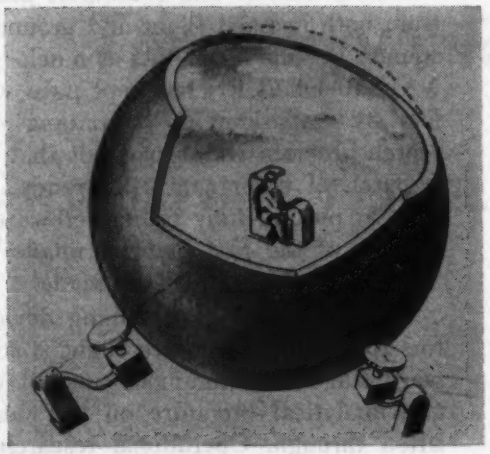

FIG. 5. DISORIENTATION and Navigation Trainer.

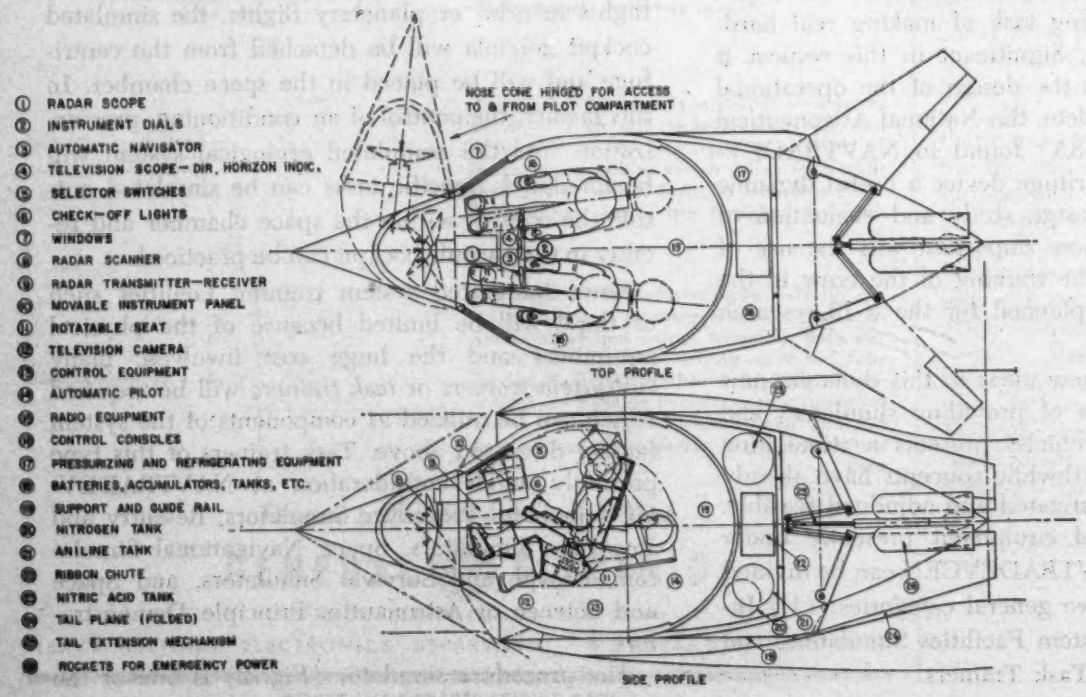

FIG. 6. ESCAPE AND SURVIVAL Trainer. Equipment items are identified at left.

less expensive types of synthetic equipment used for training, yet it can be considered a very effective familiarization trainer. In training for space flight, the procedure trainer would be used primarily for indoctrinating crews in the sequence of operation prior to launching. It will train in coordination with ground crew, count-down with flight crew procedures, and would also include ground communications or displays prior to launching. Some space flight procedures, such as release of stages of propulsion, fixing of altitude (or orbits), and exchange of intelligence, could also be included in this type of simulator.

Two phases of space flight appear to need specific types of task trainers. First, a Re-entry and Recovery Trainer will simulate the various techniques of re-entry into the atmosphere (gliding re-entry or ballistic). The trainer can also provide a means of demonstrating to the astronaut the important phases of the various operations involved in re-entry or recovery.

The procedure of actually bringing the vehicle to a final landing at a suitable location at the earth's surface will determine the technique which should be used by the trainee. Recovery may be: (1) Airborne to another vehicle, or (2) may be set at a designated landing area with specialized ground equipment. Some of the landing situations which will be encountered in operating space vehicles are illustrated in Figs. 3 and 4. The trainer used for indoctrinating spacemen on re-entry and recovery may look somewhat like a procedure trainer; however, it will incorporate only those essential training factors required for re-entry and recovery.

A second of the principal problems facing the orbital and space navigator is that of navigational guidance, involving the determination of vehicle position and vehicle velocity. It is currently planned to use inertial, radar or celestial navigation systems for space vehicles. However, regardless of the system used, critical training problems to be solved by the space crew will include velocity control, altitude control, orbiting, and position in space. These requirements for crew operations have suggested a device for space navigation simulation (Fig. 5) An engineering study on this type of simulator resulted in plans for a spherical vehicle which can rotate about any axis. The simulator will permit the direction and position of axis of rotation of the vehicle to be measured or sensed by conventional equipment. In this manner, control and stability of the vehicle can be maintained by the crew or by automatic equipment. As an orbital and space navigation simulator, force and movement-producing devices for altitude, attitude and velocity vector control would be incorporated to simulate various tasks for the flight crews.

Since these vehicles must be provided with a capability for escape and survival, flight crews will be indoctrinated with a type of escape and

survival simulator similar to that in Fig. 6. Escape procedure can be practiced in the event that the primary vehicle becomes uninhabitable and/or aborting and returning to the earth is necessary.

One of the most effective uses of demonstrators is in the dissemination of knowledge and understanding of new developments and applications. These can include such technological subjects as chemical and nuclear rocket propulsion systems; automatic flight control systems; and animated flight demonstrators to show the importance of launch velocity, transit time, lead angle and path angle flights for moon intercepts. In general, these trainers and aids would be used to develop both the general science of astronautics and the specific equipment in its application.

As is evident from this account, the Naval Training Device Center's interest in space flight and astronautics, and in the associated equipment and training problems, is not a recent development. Our obligation as specialists in training equipment is to accept space flight as feasible and practical, and to furnish the equipment and knowledge necessary to enable the Navy to develop a trained manpower as an effective component of the space weapon system of the not too distant future.

BOOK REVIEWS

DIRECTORY OF FIRMS, Their Buyers and Specifying Engineers, Industries Publishing Company, P. O. Box 621, Culver City, Calif., 130 pages, 6" x 9", $25.00. Lists 1800 buyers and 1500 specifying engineers in the aircraft, missile, space and electronic industries and the military in the 11 Western States. Names of firms and addresses also are given.

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QUALITY CONTROL MANUAL FOR PRINTED CIRCUIT BOARDS AND BOARD ASSEMBLIES, 1960, Industrial Division, Bureau of Engraving, Inc., 500 S. Fourth St., Minneapolis 15, Minn., 36 p. 8½" x 11", Air Force approved technical manual dealing with various phases of standardization, purchasing, govt. inspection, and other informational material is offered free to persons requesting same on company letterhead. Send to above address.

FOR MORE INFORMATION CIRCLE 109 ON READER-SERVICE CARD

SYSTEMS PRELIMINARY DESIGN, by Joseph J. Jerger, D. Van Nostrand Company, Inc., Princeton, N. J., 625 p., 6" x 9" $14.75. Unifying volume to "Principles of Guided Missile Design," series edited by Grayson Merrill, CAPT, USN-(Ret). A practical approach to systems design techniques.

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THE AERODYNAMICS OF POWERED FLIGHT, by Robert L. Carroll, (1960) John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. 275 p., 6" x 9", $8.50. Logical development of lift from rocket power rather than historical approach provides unique exposition of sonic and supersonic flight regimes.

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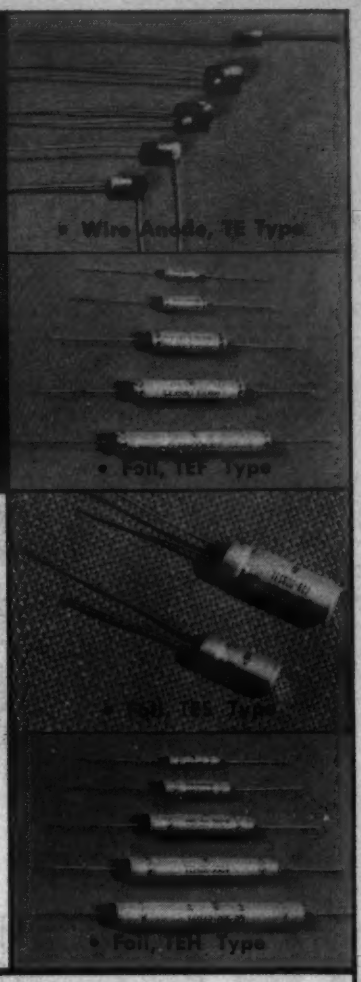

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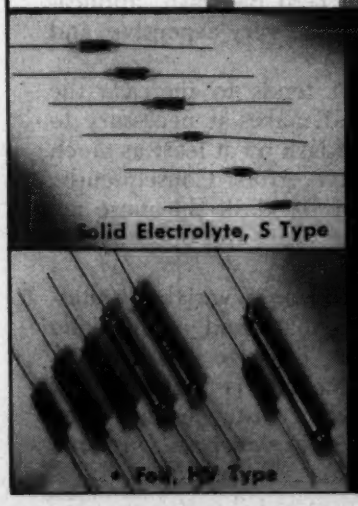
Foil, single ended	TES	—55 to +85	6 to 150	1 to 90	1.8 to 600	0.312 x 0.650 to 0.375 x 1.0
Foil, axial leads	TEH	—55 to +125	3 to 100	0.25 to 350	0.5 to 150	0.187 x 1.0 to 0.375 x 3.25
Foil, axial leads	TH	—55 to +125	3 to 150	0.15 to 350	0.28 to 580	0.187 x 0.75 to 0.375 x 2.875
Foil, axial leads	HV	—55 to +125	200 to 300	8 to 500	None	0.187 x 0.75 to 0.531 x 2.875
Wire anode	TE	—30 to +65	1 to 4	0.01 to 1	1 to 16	0.075 x 0.150 to 0.103 x 0.313
Wire anode	TEW	—55 to +71	2 to 30	1 to 4	4 to 60	0.138 x 0.219 to 0.138 x 1.0
Solid electrolyte	S	—80 to +125	6 to 35	.0047 to 60	None	0.125 x 0.250 to 0.175 x 0.438
Solid electrolyte	TS	—80 to +125	1 to 15	.0047 to 1	None	0.065 x 0.150



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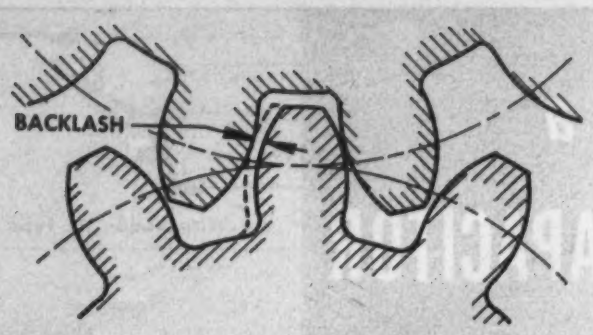
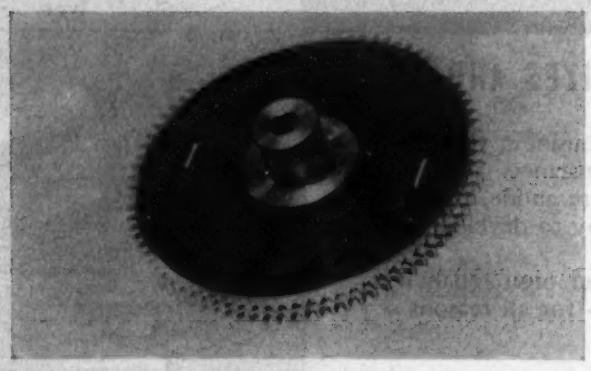


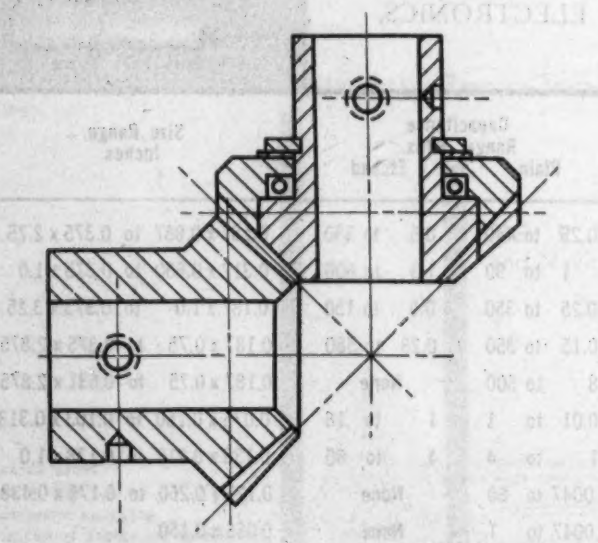
FIG. 1. BACKLASH is largest distance between non-driving tooth surfaces of adjacent teeth in mating gears, usually measured at the common pitch circle.

BACKLASH IN INSTRUMENT GEARS

WINFRED M. BERG, PIC Design Corp.



Backlash in precision gearing has become more and more critical to the engineer and designer of precise servo-mechanical systems. When our present gear standards were established, they were not made for today's precise gear cutting mechanisms, machines, inspection, and checking equipment; hence they now are obsolete. Methods of measurement, inspection and application should be more clearly defined and understood.



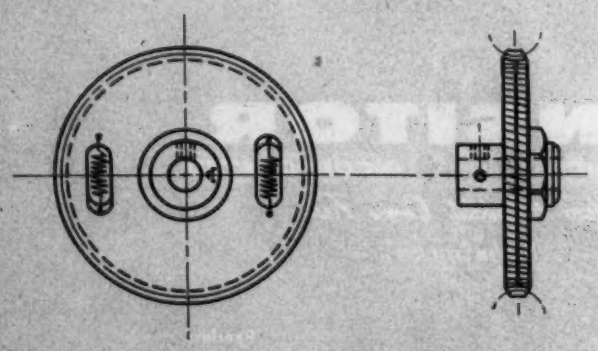


FIG. 2. ANTI-BACKLASH gears for many applications compensate for "total composite error." (a) Spur gear, (b) mitre gear and (c) worm gear anti-backlash assemblies are shown.

BACKLASH IS PROVIDED for a variety of reasons and cannot be designated without consideration of machining conditions. The general purpose of backlash is to prevent gears from jamming together and making contact on both sides of their teeth simultaneously.

Backlash is the largest distance between nondriving tooth surfaces of adjacent teeth in mating gears, or the amount of clearance between the teeth of mating gears. It is usually measured at the common pitch circle (Fig.1). It varies from 0.00000" (assuming everything is manufactured and produced perfectly) to 0.0015" in a pair of Precision 1 gears, depending on the precision class of the gear, the pitch, number of teeth and tolerance variations, etc. (So-called "Zero Backlash" applications are almost impossible and very expensive, and should always be avoided.)

Any error in machining tends to increase the possibility of jamming, and makes it necessary to increase the amount of backlash by at least as much as the possible accumulative errors. Consequently, the smaller the amount of backlash the more accurate the machining of the gears and other associated components must be.

Backlash can be measured on a variable-center-distance fixture similar to that used in checking the "Composite Error" and "Tooth to Tooth Error" in gears. In this case the backlash is approximately equal to the change in center distance multiplied by *twice the tangent of the transverse pressure angle.*

Example: 0.0001" center distance change, 20° pressure angle gear

$$\text{Backlash} = (0.0001)\ (2)\ (\tan 20°)$$
$$= (0.0001)\ (2)\ (0.36397)$$
$$= 0.000072\text{" backlash per } 0.0001\text{" center distance change.}$$

Present gear standards are not sufficiently exacting. They specify backlash in particular classes of gear as shown on Table 1. The data are based on two mating gears of like kind, measured at minimum and maximum conditions.

Maximum and Minimum Conditions

"What are Maximum and Minimum Conditions?" Today many inspection departments misunderstand this standard. It may take a half-hour to cut the gear—and days to physically find the true backlash and backlash minimum condition per outlined specification, as follows:

"1. Mesh Tooth #1 Gear "*A*" with Tooth #1 Gear "*B*," measure and record backlash.

"2. Continue meshing Tooth #1 with each other tooth cavity after all teeth in gear "*B*" have been checked and recorded.

"3. Continue operation with Tooth #2, Gear "A," etc." One can see the long and tedious time consuming problem if one checks backlash under present gear standards.

It is maintained that the time to actually control backlash is when a gear is being cut and is on the machine. This is accomplished by P.D. measurement (over wires), good tooth to tooth control,

TABLE 1—SPECIFIED BACKLASH FOR DIFFERENT CLASSES OF GEARS

Class	Diametral Pitch Range	Backlash In Two Mating Gears of Equal Tooth
A	20 to 45	0.004 to 0.006
	46 to 70	0.003 to 0.005
	71 to 90	0.002 to 0.0035
B	20 to 60	0.002 to 0.004
	61 to 120	0.0015 to 0.003
	121 & finer	0.001 to 0.002
C	20 to 60	0.001 to 0.002
	61 to 120	0.0007 to 0.0015
	121 & finer	0.0005 to 0.001
D	No measurable backlash at any pitch.	

and eccentricity control. Here one can calculate maximum and minimum backlash conditions in minutes, with true and actual known figures.

Anti-Backlash Gears have been designed to minimize backlash (Fig. 2). These spring loaded gears compensate for "Total Composite Error."

Backlash control specification should include the following: "Mark dot of blue ink on high or maximum eccentric side of Pitch Diameter."

The main purpose would be in applications having adjustable or floating center distances. Gear meshes could be controlled to minimize backlash by meshing each pair of gears at the known or worst case in maximum limits. In certain instances, only where 1:1 ratios are involved, one can mismesh gears to permit high sides to cancel out (Fig. 3).

Ultra Precision Gears

A class of "ultra precision" gears, for more accurate and precise than previously contemplated, is now demanded. This class of gear is designated with an *Indexing Accuracy of "X" seconds of arc deviation allowable,* or tooth spacing not to exceed "X" seconds of arc. It has been made possible by new hobbing machines.

A new concept in hobbing machines is being developed by the Barber-Coleman Company, a pioneer in hobbing for over fifty years. PIC Design Corp., which placed an order for the first four machines to be produced, can now produce a 64 pitch, 2½ pitch diameter gear, with an adjacent tooth deviation not to exceed 9.8 seconds and any non-adjacent teeth not to exceed 15.6 seconds!

It has been found that as a gear increases in pitch diameter, to say four inches, and as the pitch becomes finer, it is proportionately less difficult to hold tooth-to-tooth accuracy. The explanation is simple: it is known that each gear hobber has an error that has to be reflected in the finished gear; as the pitch circle increases there is more room for the distribution of the error. Likewise, as the pitch becomes finer, the number of teeth increase and again there is more room for this known error to be distributed. At present PIC is using two methods for determining the amount of tooth-to-tooth spac-

TERMINOLOGY

PRESSURE ANGLE of a gear tooth is the angle between the tooth profile and the radial line at its pitchpoint, or the angle between the line of action and the line tangent to the pitch circle. Standard pressure angles have been established in connection with standard gear tooth proportions to transmit smooth action at constant velocity with minimum interference. The basic 20° pressure angle (P.A.) is most commonly used in the fine pitch field. Fine pitch gears are stocked in 20° P.A. only for stronger teeth and smoother rolling (14½° P.A. are gears cut on request).

DIAMETRAL PITCH is the number of teeth to each inch of the pitch diameter.

CIRCULAR PITCH is the distance from the center of one tooth to the center of the next tooth, measured along the pitch circle circumference.

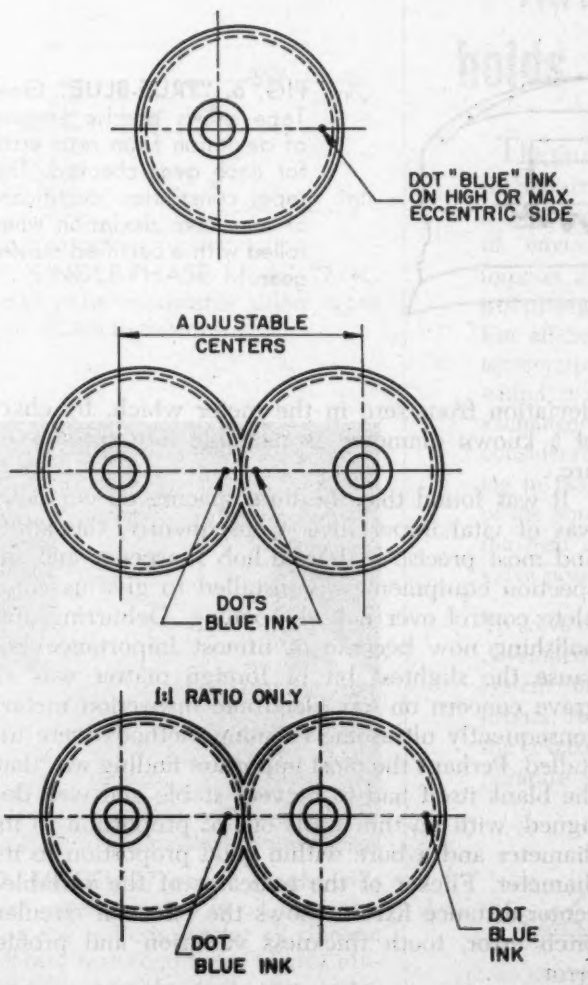


FIG. 3. MARK on high eccentric side of gear would permit control of gear mesh to minimize effect of eccentric.

OK

Flow Sheet

HOKE REPORTS ON FLUID CONTROL (2)

WE PACKED PERFORMANCE IN A PACKLESS VALVE

The development of packless valves has so greatly reduced the problems of handling high pressures, temperatures and vacuums, and dangerous fluids that engineers designing such systems can now spend more time curled up with the Hoke Corrosion Chart.*

With this extra time, many have dreamed up weird applications for the Hoke 440 Series bellows seal valve, trying to snare us in our own semantics. In a rash moment, we boasted that this valve could be modified for almost any application. Actually, the 440 can be modified to work at high pressures (up to 2000 psi), for high temperatures (up to 1000°F.), and for special connections such as tubing, socket welding, and silver brazing.

The cesium boiler shown above uses a modified version of the Hoke 440 series bellows seal valve.

Aside from this horn-blowing, here are the dry facts. The basic design includes a stainless steel body, inert arc-welded bellows assembly, Teflon gaskets and Teflon stem point discs. This is only the starting point. Minor modifications make so many models available that almost any problem, including liquid metal handling, can be solved.

Hear what a disbeliever said: "I did not believe that the modified valves would satisfy all my requirements, especially to keep a high vacuum of the order of 10^{-5} mmHg under a wide variation of temperatures; however, I now acknowledge that the modified Hoke 440 valves fulfilled their duty perfectly." This came from The Martin Company, where we sent 440's for use in cesium vapor up to 400°F. Special modifications made these valves readily usable on a cesium boiler and converted an infidel to the true valve.

If you work with critical high vacuum, high pressures, high temperatures and dangerous fluids, proceed with care. Ask for our Packless Valve Bulletin to reap a harvest of engineering plums.

*Makes good reading if you're handling corrosive agents. Write, and we'll send you one.

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FIG. 4. PRECISION Turntable method of determining tooth-to-tooth spacing error uses 70-power optical head.

FIG. 5. INDEXING plates accurate to ±2 seconds of arc are used in second highly accurate method of checking precision gears.

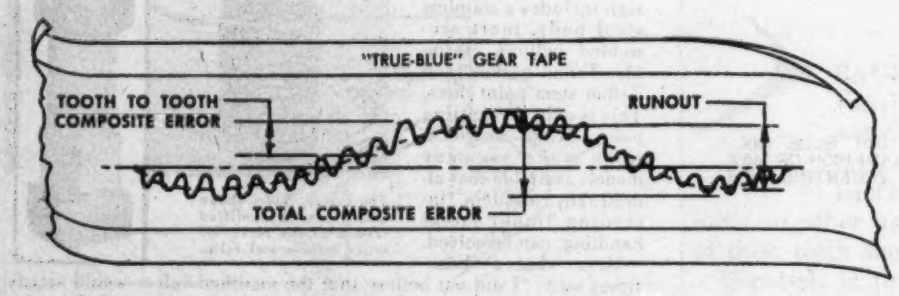


FIG. 6. "TRUE-BLUE" Gear Tape shows precise amount of deviation from zero error for each gear checked. This tape constitutes certificate of maximum deviation when rolled with a certified master gear.

ing error.

First, using (1) an ultra high precision turntable (Fig. 4) with a known accuracy of plus or minus 2 seconds in conjunction with (2) a concentrated diffused light, and (3) an optical head of 70 power, PIC is able to index from tooth profile to tooth profile with the optical system hair line tangent to the tooth profile. Angular spacing is read off the vernier and the difference from the true calculated tooth spacing is the indexing error. Tabulating this data and finding max.-min. conditions gives us our exact tooth spacing error within ±2 minutes.

Our second method uses precision centers (Fig. 5) with built in indexing plates of known accuracy of ±2 seconds. This method is especially adaptable to checking on centers or checking cluster gears. The method uses an index plate having the same number of teeth of the gear to be checked or a complement thereof. A probe is engaged in one tooth and an electronic meter readable to within ten millionths is set at zero. Then, indexing to the next tooth, the discrepancy is indicated on the deviation from zero in the meter which, by chart of a known diameter, is readable into seconds of arc.

It was found that the flute spacing on our hobs was of vital importance. Consequently, the latest and most precise hydraulic hob sharpener and inspection equipment was installed to give us complete control over hob sharpening. Deburring and polishing now become of utmost importance because the slightest bit of foreign matter was of grave concern on our electronic inspection meter; consequently ultrasonic cleaning methods were installed. Perhaps the most important finding was that the blank itself had to be very stable and well designed, with no thin walls out of proportion to its diameter and a bore within good proportion to its diameter. Flicker of the indicator of the variable-center-distance fixture shows the effect of circular pitch error, tooth thickness variation and profile error.

"True-Blue" Gear Tapes are available with all Precision 1, 2, 3, or Ultra Precision 1 gears.

FOR MORE INFORMATION CIRCLE 112 ON READER-SERVICE CARD

Radar Pulse

SILICON DIODES are replacing vacuum tube rectifiers in power supplies now being designed for pulse radar systems. Advantages gained through the use of the highly efficient diodes include increased reliability, smaller size, lighter weight and lower cooling requirements. A high degree of personnel safety also results from fewer exposed high voltage points, since many of the silicon diodes can be incorporated into the sealed supply package.

High voltage supplies such as the Model 77/HY1 and 77/4C, developed by the Prototype Transformer Corp., Bloomfield, N. J., are completely contained in a rugged hermetically sealed case designed to meet the strict performance requirements of Military Specifications.

To ensure proper spacing between high-voltage components in the power supply, all components are rigidly supported between two steel beams with all but a few internal connections made prior to casing, thus achieving the maximum resistance to shock and vibration under test conditions.

After placement in the case and making connections to terminals the unit is vacuum impregnated with oil. A space in the top section is filled with a high dielectric inert gas to permit expansion of oil due to temperature changes.

The schematic of the three-phase Model 77/HY1 (Fig. 1) shows that it requires only five external connections as compared with approximately twenty-four (24) needed in a conventional tube-type power supply. This is a marked simplification in circuitry. Also elimi-

TABLE. 1. ELECTRICAL AND PHYSICAL CHARACTERISTICS, MODEL 77 POWER SUPPLY UNITS

Duty	Three-Phase Molulator Supply to 5C22 hydrogen thyratron	Single-phase modulation Supply to 3C45 or 4C45 hydrogen thyratrons.
Input:	220 v, 3-0, 60 cps.	115 v 50-60 cps
Output:	9,000 v dc at 225 ma	4000 v dc at 100 ma
Regulation:	4.5% no load to full load	10% no load to full load
Efficiency	90% at full output	80% at full output
Filter choke:	4hy at 225 ma, 12 hy at 25 ma 360 cps ripple.	50 hy at 100 ma, 200 hy at 25 ma. 120 cps ripple.
Size:	21 ¼" x 12 ¾" x 9 ¼"	12 ⅜" x 8 ⅜" x 8 ¾"

NOTE: Customer supplies high voltage capacitor and bleeder resistor of a value suitable for the desired ripple.

Modulator uses Silicon Diodes

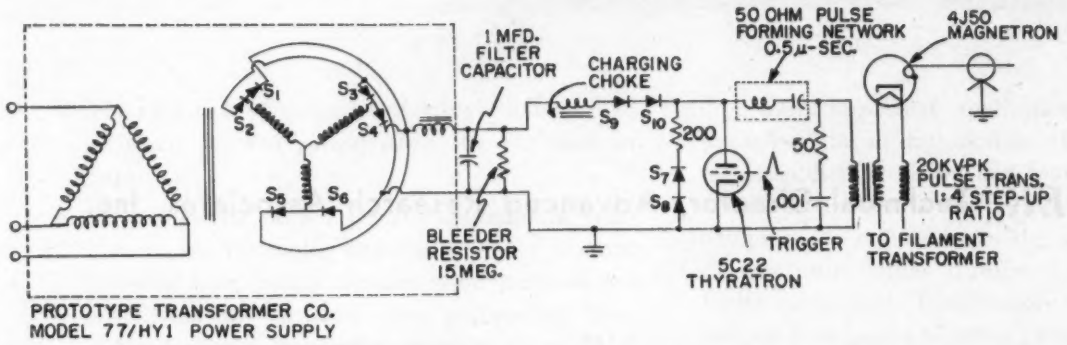


FIG. 1. TYPICAL RADAR MODULATOR circuit using 77/HY1 power supply (dotted enclosure at left) requires only five external connections to power supply unit compared to approximately twenty four needed by conventional transformer-rectifier units. Hermetic sealing of high-voltage rectifier circuit increases reliability and safety factors of modulator. Circuit component values are typical, may be varied to meet application requirements. Silicon diodes S_1 through S_{10} are rated at 150 ma dc, 8,000 PIV.

nated are tube sockets, filament transformers, chassis and other mechanical components. The entire three-phase supply is approximately equal in height to the three type 371B rectifier tubes it replaces. Because the modulator runs cooler, other radar components in the same housing show greater reliability.

In comparable fashion, the single-phase model 77/4C (Fig. 2) uses only four external connections compared with approximately fourteen for the conventional tube type supply. The sturdy construction of the two units (Fig. 3) is reflected in their electrical characteristics (Table 1).

A typical radar modulator circuit using a 0.5 μsec pulse forming network with a type 5C22 hydrogen thyratron is shown in Fig. 1. It will be noted that the capacitor of the LC filter and the bleeder resistor are not supplied as integral parts of the power supply. This is done to enable the user to choose capacitor and resistance values, in connection with the swinging choke characteristics given, best suited to his particular requirements of ripple voltage control. Also since high voltage capacitors are normally encased in oil, inclusion in the power supply case would offer no advantage.

If voltage regulation is desired, a magnetic amplifier can be incorporated in the input of the power supply, with its control tied to a voltage reference taken from a portion of the bleeder resistor.

Power supply units of the types shown have been operating in the field for over one year without failure. However, replacement of silicon diodes is a simple matter of opening a removable cover, installing new diodes and replacing the cover, which retains the hermetically-sealed feature of the power supply.

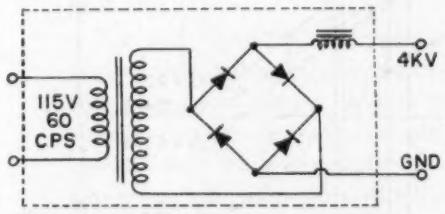


FIG. 2. SINGLE-PHASE Model 77/4C for radar pulse modulator using types 3C45 or 4C45 thyratrons.

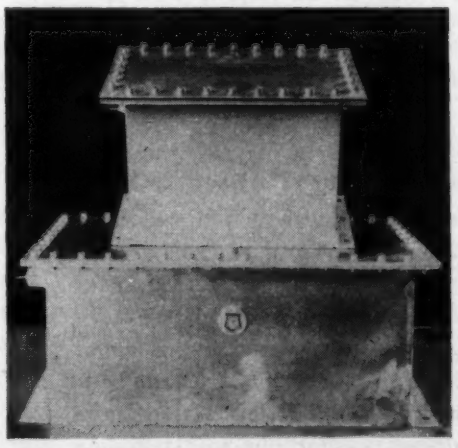
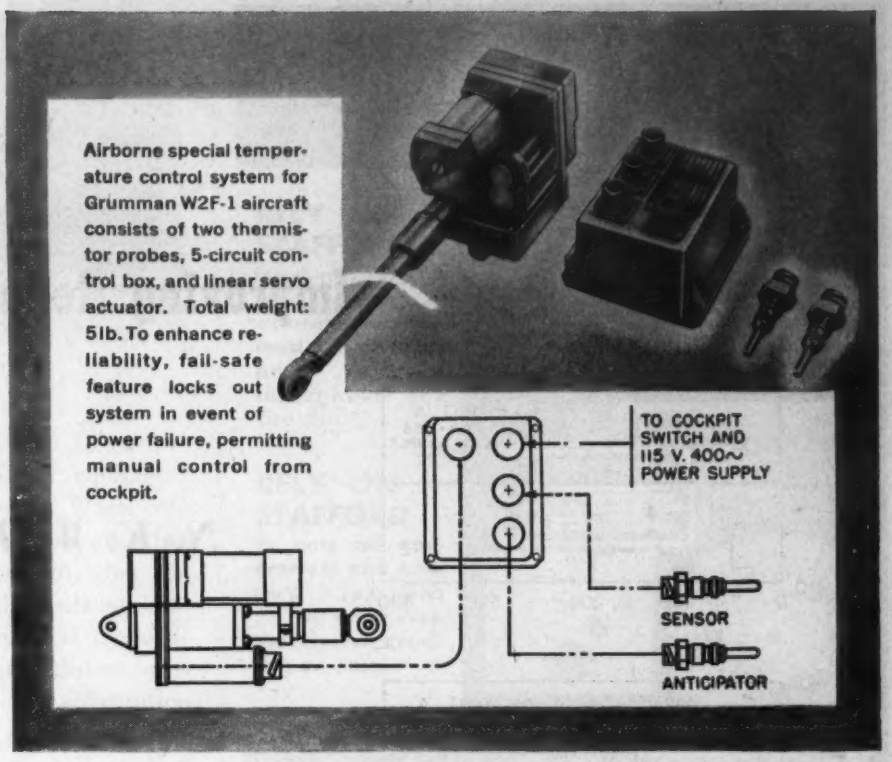


FIG. 3. MODEL 77/power supply units are hermetically sealed in oil for operation at any altitude, under all climatic and military test conditions. Highly efficient diodes operate cool, are readily replaced in the field if this is ever necessary.

FOR MORE INFORMATION CIRCLE 113 ON READER-SERVICE CARD


Airborne special temperature control system for Grumman W2F-1 aircraft consists of two thermistor probes, 5-circuit control box, and linear servo actuator. Total weight: 5lb. To enhance reliability, fail-safe feature locks out system in event of power failure, permitting manual control from cockpit.
TO COCKPIT SWITCH AND 115 V. 400~ POWER SUPPLY
SENSOR
ANTICIPATOR

Airborne special control system holds engine oil temperature to ±3° F

The Grumman W2F-1 airborne-early-warning aircraft, because it is operational over a wide range of environments and altitudes, imposes a severe problem in control of engine lube oil temperature. For efficient engine operation, oil temperature must be maintained within ±3°F at the air/oil heat exchanger. This, in spite of the considerable (10-100 sec.) time lag in the exchanger and in spite of the non-linear characteristics of the heat exchanger with ram air valve position.

To solve these problems, Airborne developed an electromechanical system utilizing two thermistor probes. An "anticipator" probe at the exchanger inlet senses temperature variations in oil coming from the engine, initiating a command to the actuator to correct the ram air valve setting. A "sensor" probe at the exchanger outlet monitors steady state temperature, comparing it with a specific temperature reference in the control box. Deviations from predetermined limits result in further correction by the actuator.

If you have electromechanical systems requirements – for aircraft, missiles or ground support equipment – we will be happy to make a proposal. Often we can meet requirements with an Airborne standard or modular system. If not, we are fully qualified to develop custom designs, as in this instance. New Catalog GC-60 gives further information. Contact any of our offices.

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Improving Reliability and Replaceability of Transistorized Systems

N. K. WALKER, Technical Director, Advanced Research Associates, Inc.

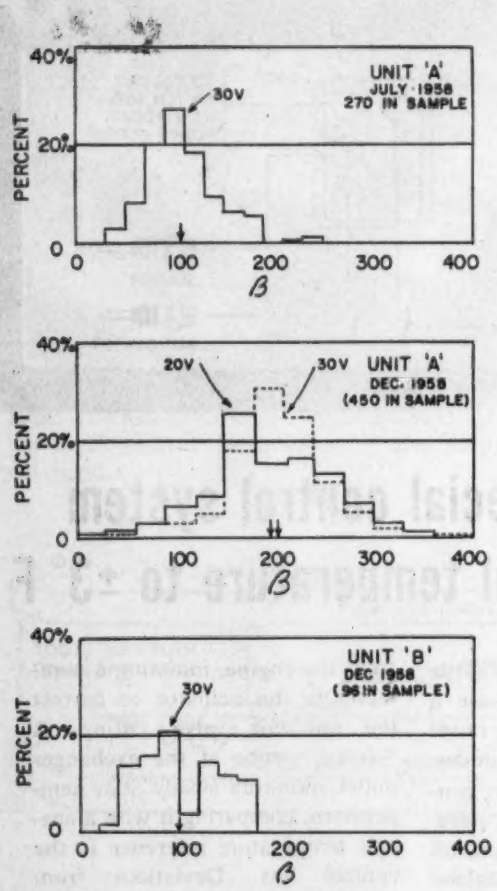


FIG. 1. GAIN VARIATIONS, both in production lots and from lot-to-lot for a typical standard power transistor.

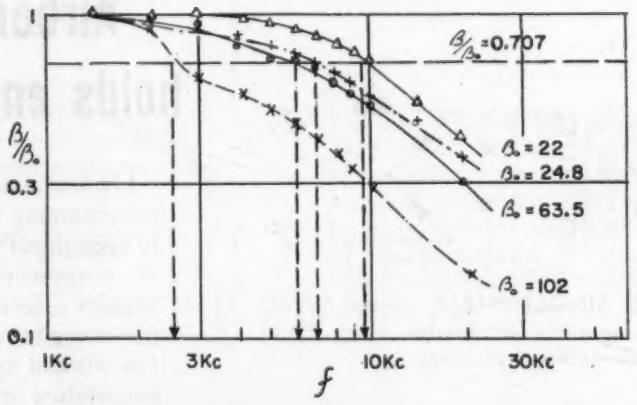
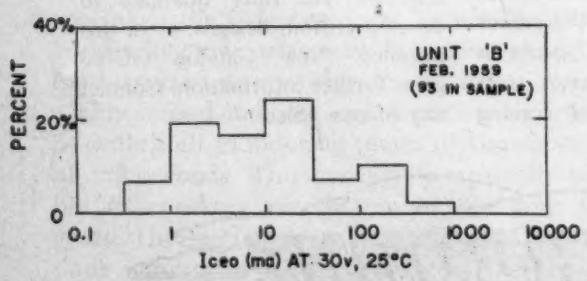


FIG. 2. FREQUENCY RESPONSE variations for a batch of four typical standard power transistors of the same type.



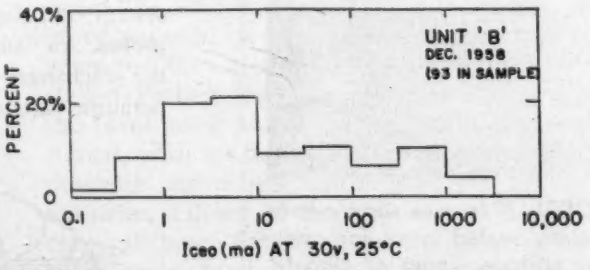


FIG. 3. VARIATION OF LEAKAGE in lots and from lot-to-lot for a typical standard power transistor.

CONVENTIONAL transistors as provided by their manufacturers suffer from a number of serious deficiencies which are not usually mentioned in textbooks or in the transistor manufacturer's technical data sheets. They are commonly discovered only when a firm new to the transistor field, but widely experienced in conventional electronic design attempts to transistorize some item of equipment. Unless the firm is so fortunate as to have the services of a very experienced transistor circuit designer, the results will be most frustrating. In some cases, this experience has led to the blanket condemnation of transistors as "tricky, inefficient and unreliable" devices. The simple truth of the matter is that for the next four or five years at least the demand for transistor circuit engineers will far outstrip any possible supply, especially when it is realized that the present textbook methods are not those currently employed by the best designers and future designers must therefore acquire the needed skills by costly experience.

The deficiencies on the standard type of transistor are highlighted by the following facts:

1. The gain variation from unit to unit is very wide and 5% of standard units will have a gain of less than half, or more than twice, the nominal value (Fig. 1). If selected units with closer tolerances are supplied the cost is considerably increased.
2. The frequency response of standard transistors is subject to as large a variation as the gain (Fig. 2).
3. All transistors can be damaged by excessive voltage. As with gain, the manufacturer's rated figures are not completely definitive.

FIG. 4. ARA COMPOSITE TRANSISTOR is a thermally compensated replaceable unit composed of matched and selected germanium and silicon junctions. One 2N626 transistor can be replaced in any circuit by any other 2N626 unit without further testing or circuit modifications. Other composite transistors in current production are also illustrated.

4. The variation of leakage under high voltage load (Fig. 3) is even greater than the variation in gain.
5. All transistors, and especially germanium transistors, are thermally unstable in most circuits. Existing temperature compensation methods are inefficient and in most cases germanium transistors are not designed to operate above 55°C and will not meet Military Specifications.
6. Every standard transistor requires a large heat sink to realize its full rated potential.

As a result, standard transistors cannot be treated as replaceable items without selection unless the circuit is so designed that it will accept variations in gain and frequency response, which in turn implies a low efficiency circuit.

Replaceability Achieved Through Composite Transistors

In comparison, the Composite Transistor (Fig. 4) developed and licensed by Advanced Research Associates, embodies a number of carefully chosen standard type transistors and diodes, subjected to 100% inspection and fitted together in a carefully matched assembly. The circuit embodies a patented thermal compensation technique using semiconductor elements which is efficient over the whole effective temperature range of the semiconductor device used.[1] It is potted into a rugged unit which provides rapid heat dissipation into any heat conductive surface.

This technique enables the ARA Composite transistors to meet the full temperature range of Military Specifications. These units are also 100% inspected before shipment and those with low thermal stability ratings rejected. The ARA Composite Transistor is therefore a true shelf item which can be used as a replaceable unit without further checking or circuit adjustment by the user.

A most important application for the Composite Transistor is in the design of military equipment for simplified servicing and maintenance. When conventional transistors are replaced, elaborate checking equipment is required and the service technician frequently ruins other transistors while replacing the faulty component. Furthermore, because of the wide tolerance on gain and other parameters, efficient operation may not be achieved by the simple substitution of a new transistor unit.

If, as has been suggested, this problem is avoided by the use of packaged throw-away amplifiers, a very large number of different packages will be required for stock, leading to almost insuperable logistics problems.

The composite transistor offers the interesting solution of the semimodular amplifier in which the necessary input and output circuits consisting only of resistors, capacitors, reactors, etc., are accessible for maintenance while accepting as a gain block one or two composite transistors which can serve as standard sub-modules in wide variety of amplifiers and other equipments. Since the resistors and other passive elements are easily checked and serviced by conventional methods, and the composite transistor is a replaceable unit which can be checked by such simple equipment as a dry battery and flashlight lamp, transistorized equipment designed on this concept is even simpler to service and maintain than standard vacuum tube devices.

Composite Transistors and Reliability

Because it is a general principle of reliability engineering that the package containing the greater number of critical components will have the lower reliability, some engineers may question the reliability of the Composite Transistor on this score.

In answer to this criticism, the 2N626 package contains the transistor elements of at least a three-stage amplifier plus additional transistor elements for temperature stability. Since, because of its higher efficiency, it is equivalent to four or five conventional transistor stages, the overall reliability will in fact, be greater. Although the ARA temperature stabilization scheme using diodes and transistors is slightly less reliable from the view of component failure than the

[1]The 2N626 and other standard ARA Composite Transistors feature a low I_{ceo} leakage, and as a further protection against thermal runaway effects the gain drops considerably at temperatures above 125°F. In applications where the reduction in gain above 125°F would be objectionable, special selection and matching techniques are available to produce special units in which gain remains stable to 165°F.

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Announcing a new series of **size 8 servo components** designed for today's high performance systems

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(HIGH TORQUE) (LOW INERTIA)

EAD's new line of Size 8 servo components are designed to meet the extreme environmental conditions and the reliability required by today's advanced control systems. From a family of six basic units, the design engineer has the selection of servo motors, inertially damped servo motors or servo motors with tachometer generators for "hi-*T*" or "lo-*J*" system needs.

As with all EAD components, these motors can be modified, if necessary, and can be supplied with a wide variety of integral gear reductions.

TYPICAL CHARACTERISTICS

- 26 volts per phase, 400 cycles
- Stall power per phase (watts):
  hi-*T* 3.0
  lo-*J* 2.8
- Max. power output (watts):
  hi-*T* .40
  lo-*J* .28
- Size 8 diameter: .750"
- Meets MIL-E-5272, MIL-E-5400.
- Ambient temperature: −55°C to +125°C.

Construction features: precision ball bearings, housing and hardened shaft all of stainless steel.

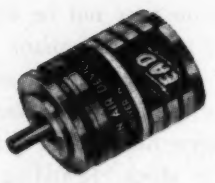
SERVO MOTORS

hi-*T*

Embraces high torque/watt ratio and adequate acceleration characteristics. Stall Torque, .35 oz-in.; Rotor inertia, .66 gm.-cm²; Acceleration, 37,000 rad./sec.²; No load speed, 6500 rpm; Damping coefficient, 36 dyne-cm-sec/rad.; 3.0 watts/phase @ stall.

lo-*J*

For low time constant and fast response to input signals in systems requiring max. torque/inertia. Rotor inertia, .17 gm.-cm²; Acceleration, 104,000 rad./sec.²; No load speed, 6500 rpm; Damping coefficient, 26 dyne-cm-sec/rad. Stall torque, .25 oz-in.



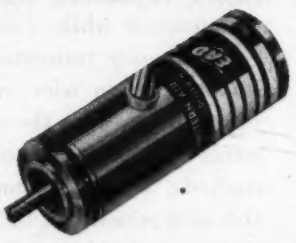
SERVO MOTORS with TACHOMETER GENERATORS

hi-*T*

Stall Torque, .35 oz-in.; Rotor inertia, .72 gm.-cm²; Acceleration, 34,400 rad./sec.²; No load speed, 6200 rpm; Damping coefficient, 38 dyne-cm-sec/rad.; 3.0 watts/phase @ stall; Gen. output, .250 v/1000 rpm; Phase shift, ±10°; Null voltage, 10 mv.; Gen. input, 1.7 watts.

lo-*J*

Rotor inertia, .23 gm.-cm²; Acceleration, 77,000 rad./sec.²; No load speed, 6200 rpm; Damping coefficient, 27 dyne-cm-sec/rad.; Gen. output, .250 v/1000 rpm; Phase shift, ±10°; Null voltage, 10 mv.; Gen. input, 1.7 watts. Stall torque, .25 oz-in.



SERVO MOTORS with INERTIAL DAMPERS

hi-*T*

Stall torque, .35 oz-in.; Rotor inertia, 1.0 gm.-cm.²; Acceleration, 24,700 rad./sec.²; No load speed, 6000 rpm; Damping coefficient, 39 dyne-cm-sec/rad.; 3.0 watts/phase @ stall; Flywheel damping, 60 dyne-cm-sec/rad.; Corner freq., .98, 2.8 and 18.5 cps.

lo-*J*

Rotor inertia, .34 gm-cm²; Acceleration, 32,700 rad./sec.²; No load speed, 6000 rpm; Damping coefficient, 28 dyne-cm-sec/rad.; Flywheel damping, 60 dyne-cm-sec/rad.; Corner freq., .77, 2.8 and 16.4 cps. Stall torque, .25 oz-in.

SEND FOR COMPLETE TECHNICAL DATA

EAD **EASTERN AIR DEVICES, INC.**
SUBSIDIARY OF NORBUTE CORPORATION
345 CENTRAL AVENUE. DOVER. NEW HAMPSHIRE

CIRCLE 21 ON READER-SERVICE CARD

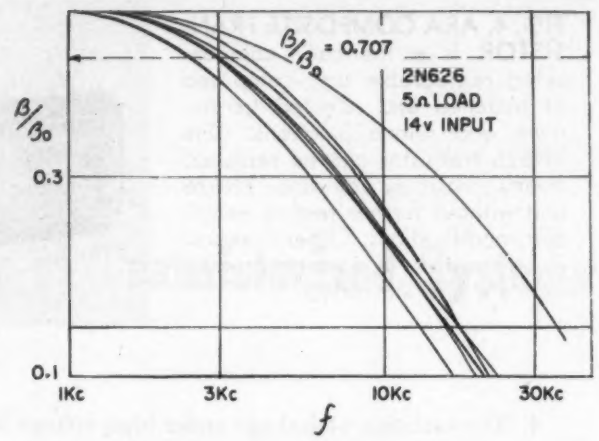


FIG. 5. FREQUENCY RESPONSE of seven 2N626 Composite Transistors show close conformity.

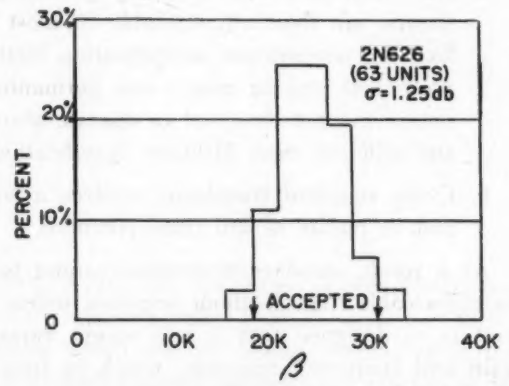


FIG. 6. BETA HISTOGRAM for a lot of sixty-three 2N626 Composite Transistors shows narrow range of variation which permits replaceability in high-efficiency transistorized systems.

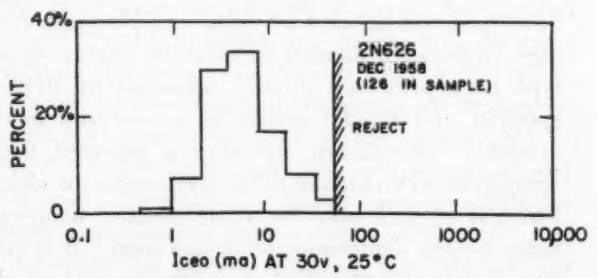


FIG. 7. LEAKAGE HISTOGRAM for a batch of 2N626 Composite Transistors shows low and consistent leakage on high voltage as compared to the variation of standard units in Fig. 3.

use of simple resistors, resistor stabilization is much less efficient and the risk of complete failure due to thermal runaway is much greater for the conventional system.

It is believed that the reliability of any circuit based on the Composite Transistor packages will be much more reliable than the equivalent circuit using unit transistors, since the Composite Transistor as supplied is as reliable as any untested single unit, due to the testing procedures used in its manufacture.

Although details of the fabrication of Composite Transistors are a commercial secret, the following

checks are applied:

1. All transistors are verified as actually being transistors. A small percentage as supplied are not.
2. Breakdown voltages are checked. A spread of breakdown voltages for a given type is centered around the manufacturer's rating, but a large percentage do not meet the manufacturer's specification. We reject those which do not meet our standard for a particular part of the circuit.
3. Leakage is checked to eliminate units which have excessive leakage, and to match the transistors with two thermal stabilizer units.
4. Gain is measured and all unit transistors are sorted into one of five classes: too high, medium, low and too low. Outer limits are rejected, which normally runs from 15% to 20% (in one excellent quality transistor, gain in a batch of 200 units measured from 28 to 180, or a six to one variation).
5. Characteristic curves for incoming units are closely inspected to detect certain irregularities which indicated probability of early failure, according to BuShips and BuOrds tests. These units are eliminated.
6. Stabilized units are matched on the basis of one high, one medium and one low gain to eliminate any large gain variation. This results in making each 2N626 Composite Transistor a truly replaceable unit with a gain tolerance from 18,000 to 30,000. The unit is then potted.
7. The potted unit is again tested to confirm good assembly and connections, and also subjected to a 40 watts load for 30 seconds to prove thermal stability. A small number of units found to be outside specified limits, although otherwise satisfactory, are used for demonstrators and samples, but not released for sale.

The 2N626 Composite Transistor is a NPN Power unit having a maximum junction temperature of 90° C, max power dissipation of 10 watts, and a frequency cutoff of 4 kc minimum. Other Composite Transistors in PNP, NPP and PNN power configurations are also available.

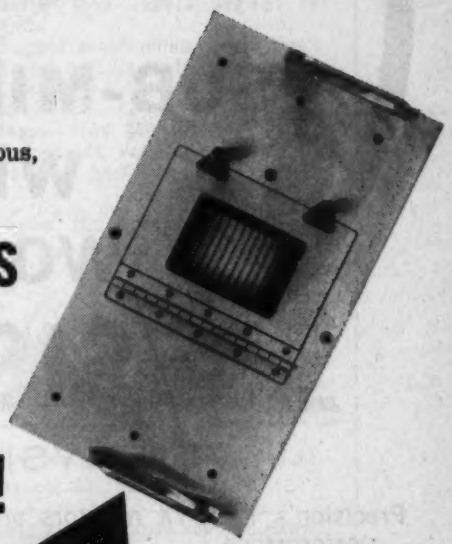
From the military standpoint, the Composite Transistor enhances reliability of equipment using transistors by the elimination of imperfect units through rigorous testing and inspection. It also ensures replaceability of transistor units to simplify maintenance and system design for maintainability. The Applications Department of Advanced Research Associates, Inc., Semiconductor Division, P. O. Box 68, Kensington, Md., will assist any manufacturer in the simplification of existing circuits or in devising new circuits to meet specific customer requirements. ARA Composite Transistor Techniques are also available to other transistor manufacturers through a licensing arrangement.

FOR MORE INFORMATION CIRCLE 114 ON READER-SERVICE CARD

This is the Clary Model 2000 series Militarized Printer. This is the one that operates flawlessly... that prints characters in a straight line within .001 inch...it even withstands such severe conditions as a 15g shock of 11 milliseconds duration and 10g's of vibration throughout the frequency range of 2 to 12,000 cycles per second.

Constructed on a sturdy panel for rack mounting, it contains all the necessary electronic equipment for data decoding, digit selections, and control functions. It employs a simple, clean, basic design that makes it adaptable to print the output from a wide variety of devices, including computers, digital voltmeters, shaft position transducers, electronic counters, and digital clocks. In addition, it is ideal in industrial applications where continuous, unfailing operation is required.

this is the printer that can take it!



Clary Model 2000 Series Printer

For complete information on how the Clary Model 2000 series printer can help you, write today for Engineering Bulletin S-120.

Clary ELECTRONICS
San Gabriel, California

CIRCLE 22 ON READER-SERVICE CARD

ACTUAL SIZE

SUB-MINIATURE WIRE WOUND RESISTORS

75 PHYSICAL SIZES

Precision's Type TX resistors are unsurpassed in uniformity of performance.

New winding techniques mass-produce resistors free from dangerous "cross-overs" and insulation breakdowns. Maximum **reliability** is assured . . . and . . . at mass-production prices.

According to your need, PRECISION'S Type TX Resistors may be had in the size and resistance value you want for your circuit. Terminals may be either axial or radial. Tolerances are standard from ±1% to ±1/20%. Where extreme accuracies are required, tolerances to ±1/100% may be obtained . . . inductively or non-inductively wound.

Military requirements are to PRECISION'S specifications.

PHYSICAL SIZE: Available in 75 sizes, ranging from diameters from 3/32" through 3/8" and lengths from 3/16" to 1-1/2".

RESISTANCE RANGES: From .01 ohm through 5.0 megohm — in any resistance value required or decimal part thereof.

ACCURACY: ±5% to ±1/20%. Tolerances ±1/50% to ±1/100% (absolute) available on specification.

TEMPERATURE COEFF. OF RESISTANCE: Standard ±0.001%°C. throughout. Special temperature coefficient + 5000 ppm° to ±1 ppm°C.

For complete information about PRECISION'S Sub-Miniature Type TX Resistors, write to:

PRECISION RESISTOR Co., Inc.
MANUFACTURERS OF WIRE WOUND RESISTORS EXCLUSIVELY
119 U. S. Highway #22, Hillside, New Jersey

CIRCLE 23 ON READER-SERVICE CARD

Burst Transmission of Digital Combat

FIG. 1. RAPID REPORTING of Combat Information in digital form is achievement of Marine Corps BASIC system. Digital burst transmissions are difficult for enemy to intercept and to decode, arrive at G-2 Command Post in a form readily processed, disseminated and evaluated.

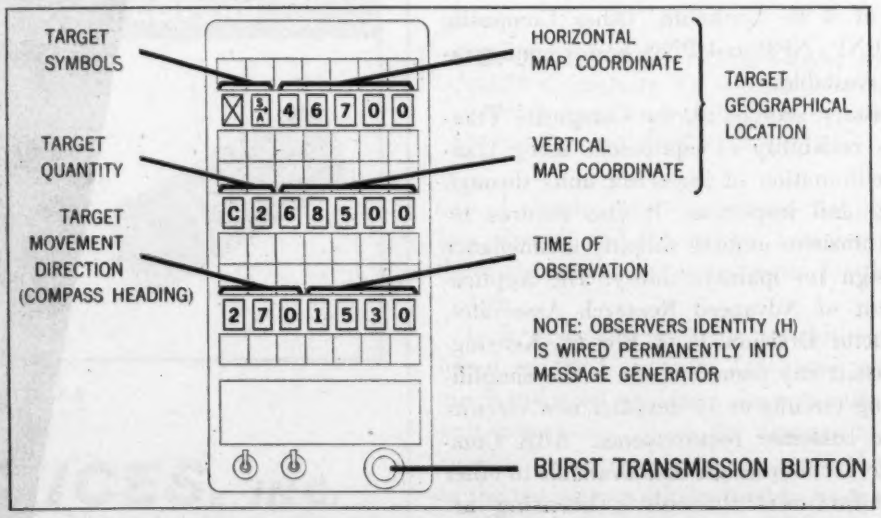

TARGET SYMBOLS
TARGET QUANTITY
TARGET MOVEMENT DIRECTION (COMPASS HEADING)
HORIZONTAL MAP COORDINATE
VERTICAL MAP COORDINATE
TARGET GEOGRAPHICAL LOCATION
TIME OF OBSERVATION
NOTE: OBSERVERS IDENTITY (H) IS WIRED PERMANENTLY INTO MESSAGE GENERATOR
BURST TRANSMISSION BUTTON
S-A 4 6 7 0 0
C 2 6 8 5 0 0
2 7 0 1 5 3 0

FIG. 2. MESSAGE GENERATOR, hand-held unit carried by forward observers, plugs into field radio, does not interfere with use of radio.

Information

R. S. STONER
Lt. Col. USMC (Ret)

IN COMBAT, it is axiomatic that reconnaissance personnel report information on the enemy accurately and swiftly to G-2. Time is of the essence. Observers must tell their command post instantly the type of enemy sighted, how many, their direction of movement and their exact location.

Conventional voice communication often takes too long. Errors can occur in reporting the detailed message. Time is lost in comparing information received from various sources and in processing it into intelligence on which a command decision for effective counter action can be based.

In response to an urgent need expressed by the U. S. Marine Corps for an accurate, high-speed method of reporting field observations over long distances, Stromberg-Carlson-San Diego, a Division of General Dynamics Corporation, has designed the *B*attle *A*rea *S*urveillance and *I*ntegrated *C*ommunications (BASIC) System. This fast, efficient system, compatible with present and future military field communications systems, is being field tested in prototype during summer maneuvers.

Method of Operation

Observers are equipped with small, hand-held digital message generators on which reports are "set up" through a series of digital switches (Fig. 1). Selected characters, numerals, and symbols appear in small windows on the box, allowing the observer to sight-check his message prior to transmission.

Then, by simply pressing a transmission button, he sends the entire message in a short burst through his standard field communications equipment (radio or wire) to the command post. The burst transmission doesn't interfere with simultaneous voice transmission over the same channel, which remains available to back up the digital transmission if required.

At G-2, the surveillance information is stored in a memory drum and immediately printed on hard copy. Simultaneously, by means of Charactron(R) shaped beam tube techniques, the information is displayed on a tactical map optically registered to the face of the tube. Shown are target, identity, exact geographical information, numbers and other important information. From this, commanders can swiftly evaluate the situation and take appropriate counter action.

Because of its high transmission rate, BASIC adds security to field communications. Its range is limited only by the range of the associated communications equipment used. The small size of the message generator enables information to be transmitted from any location where a Marine can be stationed with his normal field communications equipment. Observers may be on foot or in jeeps, tanks, helicopters, aircraft, or landing craft. The data processing, readout and display units may be carried in any type of vehicle, including handcart, because of their portable "block" construction.

Present BASIC equipment has been fabricated by commercial packaging methods. Future designs will adhere to military packaging specifications making for lighter weight and more rugged units. The new designs and methods of information display by terminal equipment will make airborne installation in light aircraft practical.

The advantages of the BASIC system of reporting are readily adaptable to rapid enemy contact reporting by scout planes, submarines and surface units in time of war. Ships at sea could use the method for digital position reporting over UHF communications networks, enhancing station-keeping in dispersed formations, providing better security, and conserving radio channel facilities.

Since BASIC is adaptable to any situation where information is transmitted in digital form, it has many military uses other than gunfire spotting and target designation. Such data as battle casualties, troop movements, air and road traffic, and inventories at supply depots can also be reported.

Another advantage of BASIC makes it particularly suited to troop maneuvers involving international forces such as NATO troops. The faceplate of a message generator can be in one language while readout by the terminal equipment is in another. For example, a French observer can insert information in his message generator modified with a French language faceplate while Terminal Equipment reports in English.

Non-military applications of the BASIC concept are legion, ranging from possible transmission of "Buy" and "Sell" orders on the floor of a stock exchange, to automatic transmission of private aircraft locations, reporting of forest fires, or automatic reading of utility meters.

Mechanics Of The System

The 15 message generators devised for the Marine Corps now weigh approximately eight pounds each. Stromberg-Carlson engineers expect to reduce even further the size and weight of the generators.

In operation, the observer plugs the hand-held message generator (Fig. 2) into his normal radio

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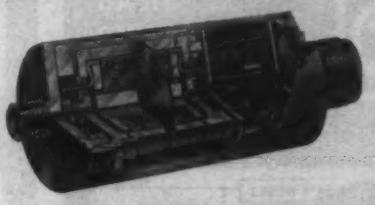

PRESSURE TRANSDUCER

- Variable Reluctance Type
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CIRCLE 24 ON READER-SERVICE CARD

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NEW! GRAPH RUBBER STAMP

Solves problem of recording graphed material neatly in engineering notebooks, reports, correspondence, etc. without using bulky sheets of graph paper. Simply stamp a clear graph pattern wherever needed. Use for electronic design, development and research records—plotting various curves from analytical data and math formulae—drawing curves from oscilloscope screens, etc. For all engineers, sales mgrs., production control. Pattern is 100 blocks per sq. in.
No. 50,255-AN (5" square) .....$3.00 postpaid

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Other American made stereos cost $350.00 to $400.00 and more! Now—save well over 50%! Up to 3" Working Distance—Wide 3 Dimensional Field Used in production, in research, or at home; for inspections, examinations, counting, checking, assembling, 2 sets of objectives on rotating turret. Standard pair of wide field 10X Kellner Eyepieces give you 23 power and 40 power clear, sharp, erect image. Helical rack and pinion focusing. Interpupillary distance adjustable. SO GOOD WE'LL SHIP ON TEN-DAY FREE TRIAL.
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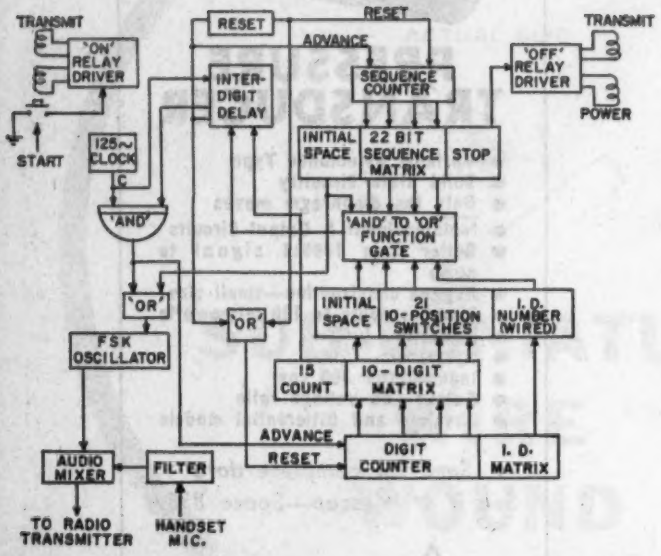


FIG. 3. MESSAGE Generator Block diagram. Burst transmission of information in digital form is initiated when "Start" button is closed.

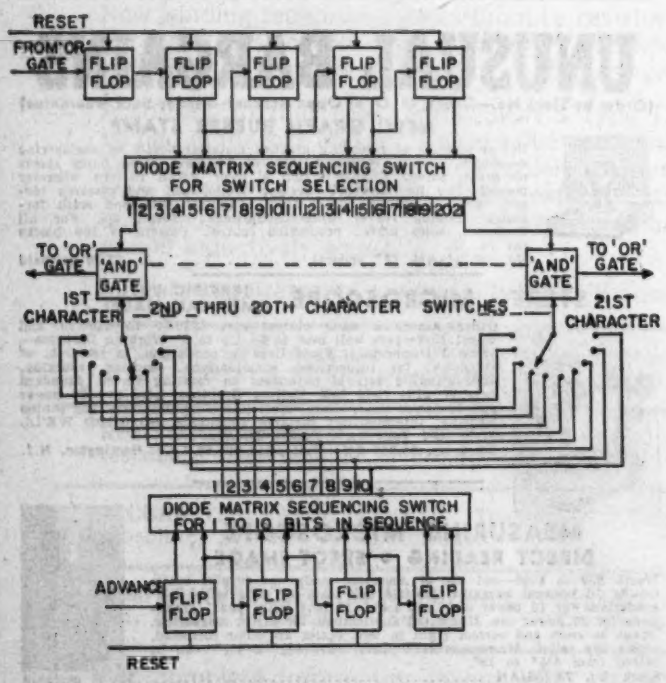


FIG. 4. LOGIC CIRCUITRY relating to a portion of the message generator circuit.

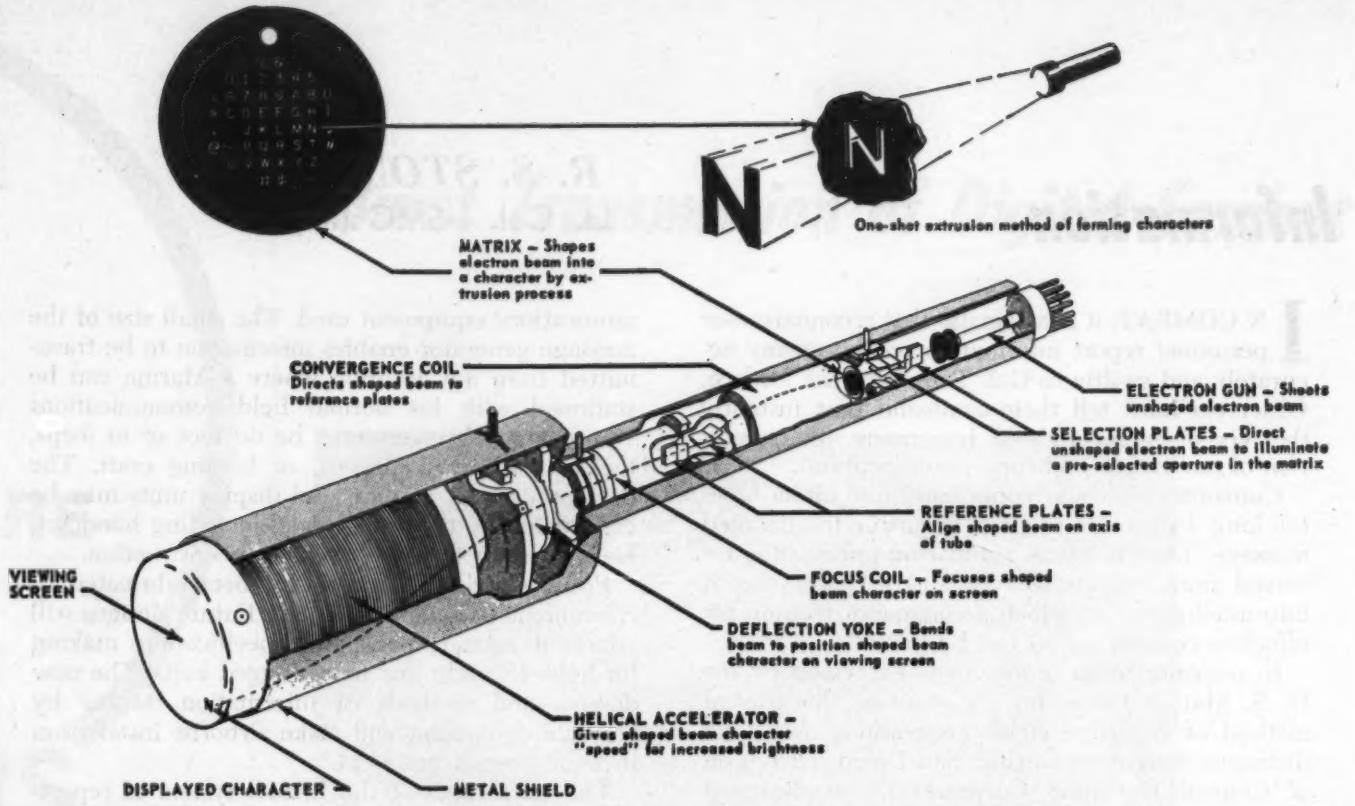

One-shot extrusion method of forming characters
MATRIX – Shapes electron beam into a character by extrusion process
CONVERGENCE COIL Directs shaped beam to reference plates
ELECTRON GUN – Shoots unshaped electron beam
SELECTION PLATES – Direct unshaped electron beam to illuminate a pre-selected aperture in the matrix
REFERENCE PLATES – Align shaped beam on axis of tube
FOCUS COIL – Focuses shaped beam character on screen
VIEWING SCREEN
DEFLECTION YOKE – Bends beam to position shaped beam character on viewing screen
HELICAL ACCELERATOR – Gives shaped beam character "speed" for increased brightness
DISPLAYED CHARACTER
METAL SHIELD

FIG. 5. CHARACTRON shaped beam tube is heart of rapid display and printing of digital burst transmission at G-2 Command Post. Message transmitted by Marine observer positions symbols on face of tube to provide printed contact report within 3½ seconds after "Transmit" button is pushed.

gear. He sets up his message by means of 21 digital switches which store the symbols and numbers to be transmitted. These give X and Y coordinates on a standard military map target, weapon symbols, quantity, direction and time. Observer identification is generated by an automatic device built into each message generator.

Before the operator sends his message, he may sight-check it for accuracy by means of small windows on the message generator. He presses the transmission button, and the circuits inside the message generator transmit the message instantly through the radio.

At the command post, it passes first through a frequency shift detector. In this circuit, small changes in audio frequency are detected as digital "Ones" and "Zeros" to activate the word assembly unit.

Within the word assembly unit the burst-type signal is assembled into a series of 7-bit words. One of the bits determines whether the electric typewriter will type in upper or lower case. The remaining 6 bits form words to energize the type bars. With only slight decoding, the same bits select the proper character in Charactron shaped beam tube matrix for the visual display. (Fig. 5).

The word assembly unit enters the target coordinates into a coordinate converter, where they are changed to absolute geographic coordinates.

The information is then displayed, optically superimposed, on a standard military map (Fig. 6). The map section used is viewed directly by the operator through a half-silvered mirror and a non-reflective viewing port; electronic information from the face of the tube is reflected from the same half-silvered mirror. Characteristics of the mirror are such that with proper positioning of the tube and map, the electronic image is optically superimposed on the map, and both are viewed in the same plane.

Illumination of each character at least 15 times per second produces a flicker-free display. Selective format suppression features permit the operator to retain on the tube face only that part of a message format that is desired. A category select feature permits selection of target types for viewing.

As another important feature, particularly in fast-moving situations, new targets appearing on the display are identified as such by a blinking presentation on the tube face. The blinking is turned off manually by the operator.

When information is flashed on the display unit it is simultaneously printed on a 3 x 5 inch card, serving as a permanent record. The entire process

FIG. 6. CHARACTERS AND SYMBOLS positioned by Charactron shaped beam tube are superimposed on standard military map to form situation display at G-2. New information "blinks" to attract attention of G-2 operator in rapidly-moving developments.

from the time the transmission button is pressed to the completion of typing takes only 3½ seconds.

The concept of BASIC grew out of a study, started over three years ago, in which Stromberg-Carlson-San Diego worked closely with the Marine Corps to build a portable efficient battlefield intelligence reporting system. It was felt that under new military concepts and techniques, spurred constantly by the changing world situation, the system had to fit the first requirement of the Marines —readiness to move out fast to counter aggression. Thus the needs of the combat Marine were always considered in the study.

Close liaison with the Marine Corps, including participation by Stromberg-Carlson personnel in field troop maneuvers at Camp Pendleton, Calif., enabled them to learn first-hand the problems of a battlefield tactical and intelligence system. The result was BASIC, an electronic system that presents tactical intelligence from the observer to his command post instantaneously.

Through BASIC, command receives a comprehensive picture of a battle situation, as it exists at any given moment, with greater speed, accuracy and security than ever before. This contribution to military surveillance is but one of the many ways that Stromberg-Carlson-San Diego is applying its electronics system capabilities to difficult problems of government and industry.

FOR MORE INFORMATION CIRCLE 115 ON READER-SERVICE CARD

BASIC BUILDING BLOCKS FROM KEARFOTT

NEW HIGH PERFORMANCE

Size 8 Motor Generator

This new Size 8 high performance servo motor-generator features high signal output and extremely low null voltage. The signal-to-noise ratio of 100:1 and linearity of 0.2% make the application of this motor generator to lightweight integrator packages most desirable. Stainless steel construction and thermal stability of this component assure its reliability and long life in the most severe environments.

ELECTRICAL CHARACTERISTICS

Motor Section	Generator Section		
	Phase 1	Phase 2	Excitation
Voltage (volts)	26	40	26
Frequency (cps)	400	400	400
Current (ma)	110	77	72
Power Input (watts)	2.3	2.3	1.3

GENERATOR SECTION OUTPUT

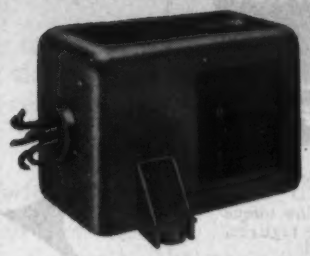
Volts at RPM (mv)	10
Volts at 1000 RPM (volts)	1.1
Output Impedance (ohms)	21 + j2500
Rated Load (ohms)	100,000

MECHANICAL CHARACTERISTICS

No Load Speed (RPM)	6500
Stall Torque (In. Oz.)	0.25
Rotor Moment of Inertia (gm-cm²)	1.2
Theoretical Acceleration (Rad/Sec²)	14,400
Weight (Oz.)	3.9

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT



QUADRATURE REJECTION CIRCUIT

Kearfott's quadrature rejection circuit is designed to operate from a preamplifier or gain controlled amplifier into a transistor servo amplifier. This small, light and rugged device rejects the component of the input wave which is 90° from the reference input. The component of the input sine wave which is in-phase with the reference will produce a square wave whose magnitude is proportional to load and magnitude of in-phase signal. Kearfott's high-performance rejection circuit is designed to operate in an ambient temperature range of −55°C to +115°C at unlimited altitudes.

TYPICAL CHARACTERISTICS /D4816-01

Input Impedance — In phase signal component (ohms)/5000 $+R_L$ / Quadrature component (ohms)/5000 (min)

Signal Frequency (cps)/400

Max. Signal Input (volts RMS)/6

Bandwidth (cps)/6

Quadrature Rejection Ratio:

Rejection Ratio (min)/50:1/35:1/35:1

Signal Input/0.15 to 4/4 to 6/0.005 to 0.15

Meets environmental requirements of MIL-E-5272.

Write for complete data.

BASIC BUILDING BLOCKS FROM KEARFOTT

TWO AXIS ACCELER-OMETERS

Highly precise and accurate, Kearfott two axis accelerometers are pendulous devices which sense airframe acceleration forces acting on them in aircraft and missile guidance systems, navigational computers and wherever acceleration must be measured precisely and translated into electrical output signals.

The pendulum is anchored to a housing by means of a unique Hooke's joint type spring suspension. Whenever there is relative motion between pendulum and housing due to acceleration, an AC excited, air-core differential transformer type pickoff produces a voltage which is a servo error signal that is fed into an AC to DC amplifier. Feedback signal in form of a DC current transmitted to a restoring coil produces a force that exactly balances force of any accelerations acting on pendulous mass.

TYPICAL CHARACTERISTICS

Range of Measurement: ± 25g (can be adjusted upward within amplifier limits.)

Scale Factor (Output): 5.0000 MA/g of applied acceleration.

Operating Temperature: Performance is optimized within any 20°F range between +50°F and +160°F.

Linearity (Output): Within ± 0.005% of the applied acceleration.

Threshold: Less than 2×10^{-7}g.

Zero Stability: ± .00005g day to day; less than ± .00002g over any continuous time interval.

Vibration: Up to ± 5g peak from 20 to 2000 CPS.

Storage Temperature: −60°F to +170°F.

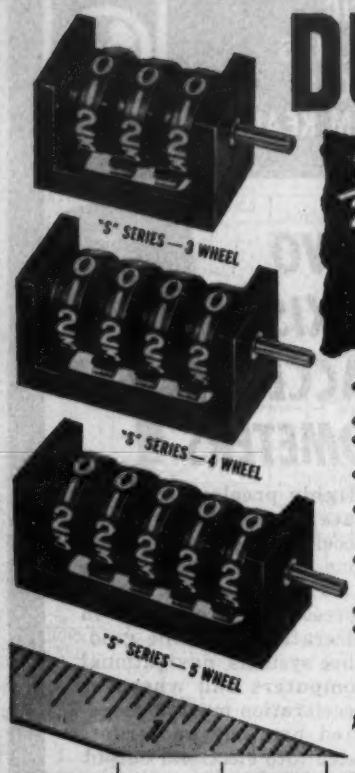
Scale Factor Variation: ± 0.01% randomness.

Write for complete data.

KEARFOTT DIVISION
Little Falls, New Jersey

GENERAL PRECISION, INC.
Other Divisions: GPL, Librascope, Link

CIRCLE 26 ON READER-SERVICE CARD



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CIRCLE 28 ON READER-SERVICE CARD

Alphanumeric Characters on any Cathode Ray Tube

ALPHABETIC AND NUMERIC SYMBOLS can be written in a simplified but highly legible format formed from one of the two Alphadyne matrices (Fig. 1). The Alphadyne system of character generation, a development of the Skiatron Electronics & Television Corp., New York 14, N. Y., uses exclusively solid-state electronics and is available in three models: Series 2000 (Fig. 2), using an 8-stroke matrix, forms all digits and twelve selected letter symbols; series 3000, with a 16-stroke matrix, forms 40 characters in all; while Series 4000, using the same matrix, supplies additional transistorized circuit cards for each 24 characters above the 40 provided by series 3000.

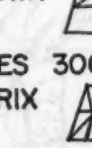
Because the Alphadyne provides a central source of character generation which can supply remote displays, a number of cathode ray tubes can be driven simultaneously to provide identical displays or on a time-shared basis for different presentations.

Applications of the new technique include identification of radar blips in ASW or Air Intercept displays, as a "quick check" computer readout, as an electronic typewriter and as a "tote board" display.

Crisp, clear characters result from the Alphadyne system of writing. The characters can be made as large as the tube face or reduced in size until the CRT resolution becomes the limiting factor. The matrices are formed by a generation of X- and Y-axis deflection voltages which are continuously traced at rates determined by the model and application as high as 40,000 characters/sec for the 2000 series and up to 17,000 for the more sophisticated series 3000 and 4000. Simultaneously, intensification voltages are generated which illuminate those matrix strokes required to form the particular character desired.

The technique of formation is suggested by the block diagram Fig. 2. It will be noted that one input line is required from each character selection source. Translators may be used if input data is in any other form. Horizontal and vertical positioning of each character is also provided by such a system (Fig. 3). Positioning of symbols may be in horizontal lines in printed text style, or tied in with radar circuits to identify with radar blips.

If the display is to be viewed visually, each matrix is repeated about 20 times/sec to avoid flicker, resulting in a 1200 cps minimum writing rate for a 60 character display. If photographic techniques are to be used, or if the display is to be used with a computer operating at real-time rates, higher minimum rates may be desirable. This will require calaculation to determine optimum writing speed which will be related to character size, lens opening, film speed, CRT spot size, CRT light output, CRT persistence, and computer rate.

SERIES 2000 GENERATED CHARACTERS
MATRIX 

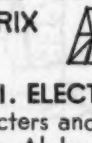
SERIES 3000 GENERATED CHARACTERS
MATRIX 

FIG. 1. ELECTRONIC generation of alpha-numeric characters and symbols follows one of two matrices in the Alphadyne System. These symbols can be controlled in size and position and provide an exceptionally versatile system of display which can be utilized with a wide variety of cathode ray tubes.

Developed character length must be computed before effective light output can be determined. For the Series 2000 Alphadyne the developed character length is approximately:

$$L \cong 3H\ (A+1) \qquad (1)$$

where: H is character height, A is character width/character height, and L is developed character length.

For the Series 3000 Alphadyne, the developed character (L) length is approximately:

$$L \cong 5H\ (A+1) \qquad (2)$$

Linear writing speed (S) is then:

$$S = W \times L \qquad (3)$$

where: S is linear writing speed, W is character writing rate, and L is developed character length.

Linear writing speed (S) is used to determine if the CRT phosphor will respond in the required time.

The CRT spot "dwell time" which can be considered as an equivalent shutter speed is determined from:

$$T = D/S \qquad (4)$$

where: T is effective shutter speed, D is spot diameter, and S is linear writing speed.

This equation neglects the effects of CRT phosphor persistence, which tends to increase equivalent shutter speed.

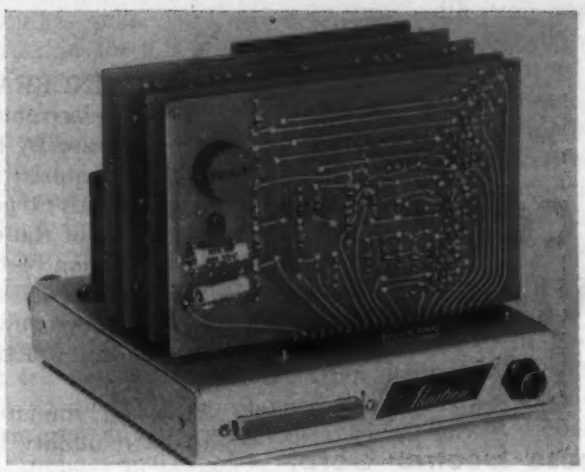


FIG. 2. ALPHADYNE CHARACTER generator, Series 2000. All-solid-state electronics in modular construction provide reliable yet readily modified circuitry to meet individual system requirements.

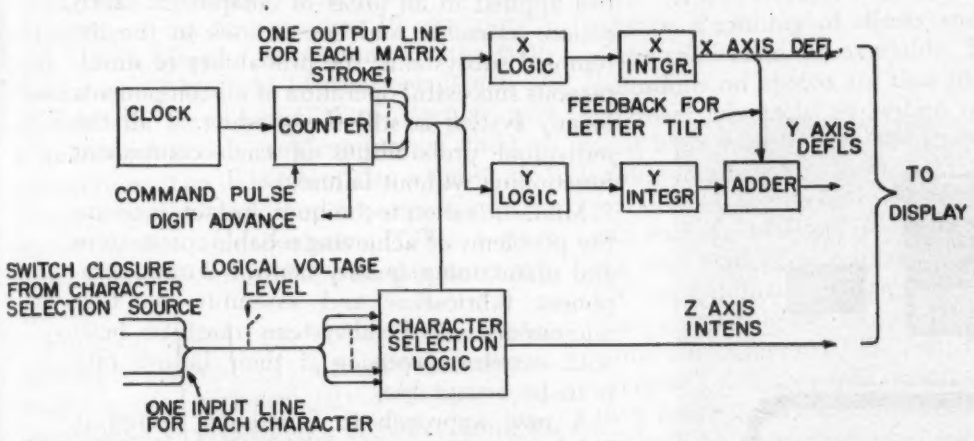


FIG. 3. BLOCK DIAGRAM of Alphadyne Character provides identical displays on a number of cathode ray tubes or different presentations on a time shared basis.

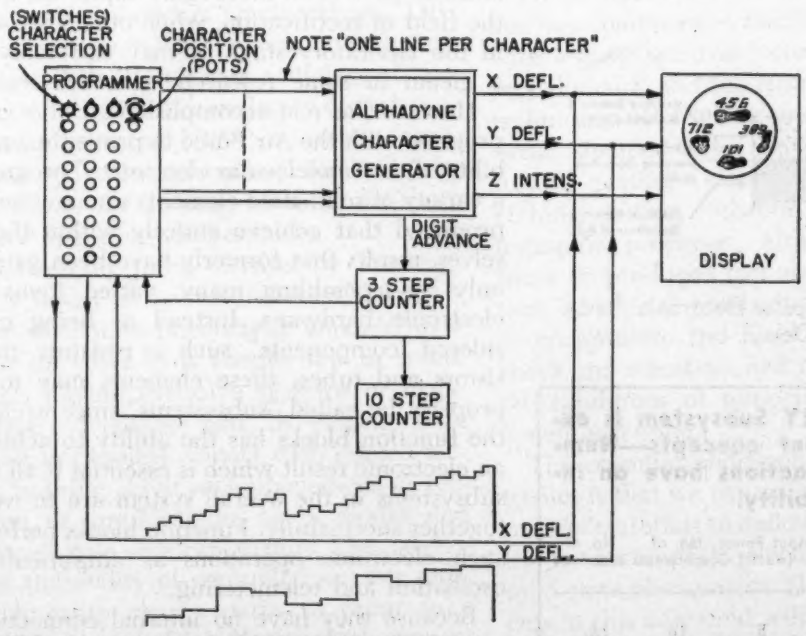


FIG. 4. MANUAL PROGRAMMED Display System shows method of positioning identification symbols on radar tube presentation. Digital formation and positioning techniques employed are also readily adapted to automatic programming.

To determine system parameters, linear writing speed (S) would first be computed to check that the phosphor will respond rapidly enough. Next the effective shutter speed (T) would be computed. It would be used in combination with the phosphor light output to determine a suitable combination of lens opening (f number) and recording film speed.

Since film tends to integrate light output, a higher f number or a slower film speed could be used if the character is rewritten repetitively in the same location.

Bandwidth Requirements

A number of strokes are required to generate each character . . . the series 2000 character matrix uses a total of 9 strokes and the series 3000 matrix uses a total of 20 strokes. Deflection circuit bandwidths are related to the character writing rate and the number of strokes in the matrix. Recommended deflection circuit bandwidth is:

$$BW = 7 \times N \times W \qquad (4)$$

where: BW is bandwidth in cps, N is total number of strokes in matrix, W is character writing rate in characters/sec.

Suppose a Type SCG2001H Alphadyne is being used (character writing rate 10,000 characters/sec.). The horizontal and vertical deflection circuits would require a bandwidth of:

$$BW = 7 \times 9 \times 10{,}000$$
$$BW = 630\text{kc}$$

to prevent degradation of the displayed characters.

This bandwidth is readily obtained from CRT using electrostatic deflection. However, some care must be taken with systems using electromagnetic deflection. The practical limit on conventional electromagnetic deflection circuits is a bandwidth of about 25 kc. For higher bandwidths, at least two techniques are often employed:

(a) "Woofer-tweeter" dual deflection yoke systems are available. The "woofer" yoke operates at the lower bandwidth and provides ±30° deflection used for *positioning* the character, while the "tweeter" yoke may have bandwidths of 1mc or more and provides ±1° deflection, which is adequate for *character formation.*

(b) CRT are available which provide electrostatic deflection plates and can simultaneously be used with electromagnetic deflection yokes. Character forming deflection voltages are applied to the electrostatic plates, and character positioning deflection voltages are applied to the deflection yoke.

Application notes and an illustrated brochure which includes theory of operation detailed specifications and additional design considerations, are available on request. Skiatron designers have developed a variety of translating positioning and programming modules to permit a wide variety of applications; and in addition welcome inquiries for custom applications which may require variations from the standard Alphadyne matrices.

FOR MORE INFORMATION CIRCLE 116 ON READER-SERVICE CARD

BENDIX
MS-R
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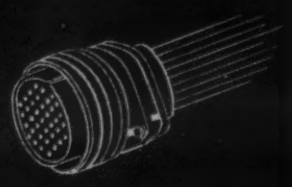
Connectors



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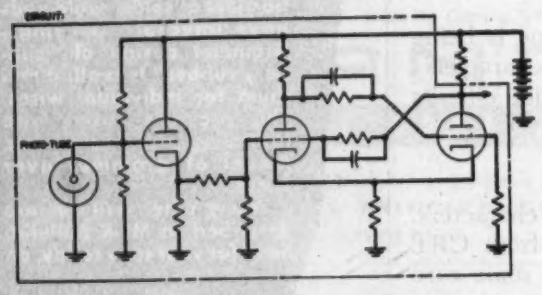
CIRCLE 29 ON READER-SERVICE CARD

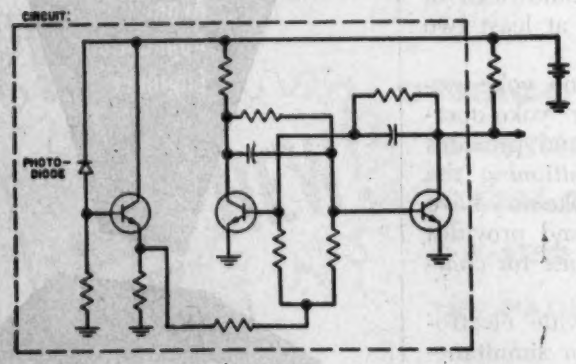
FUNCTIONAL COMPONENTS—A CONCEPT OF MOLECULAR ELECTRONICS

DR. S. W. HERWALD, Vice-President Research, Westinghouse Electric Corp.

A. YESTERDAY'S PHILOSOPHY OF CIRCUITS (LIGHT TELEMETERING SUB-SYSTEM)



B. TODAY'S MODERN PHILOSOPHY OF CIRCUITS (LIGHT TELEMETRY SUB-SYSTEM)



C. TOMORROW'S MOLECULAR ELECTRONIC SYSTEMS CONCEPT (LIGHT TELEMETRY SUB-SYSTEM)

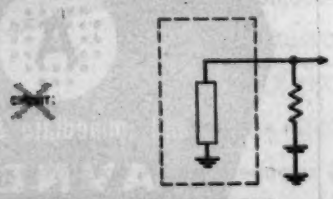


FIG. 1. TYPICAL SUBSYSTEM, a Light Telemetry pickup and amplifier, is engineered in accordance with three philosophies; using conventional tubes and components, by miniaturized solid-state and passive components, and by molecular circuitry. Comparative space, weight, volume and reliability factors are shown in Table 1.

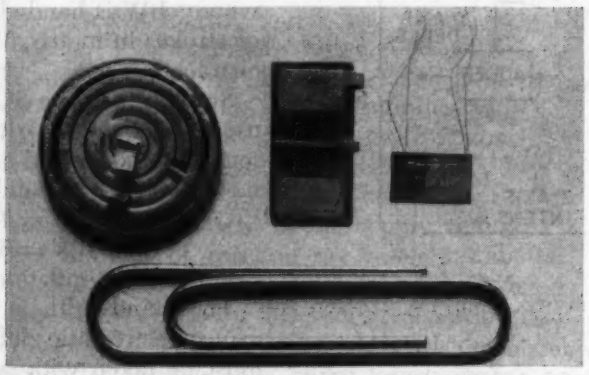


FIG. 2. THREE MOLECULAR Electronic Function Subsystems, left to right: Audio Amplifier, response 0-20,000 cps, has 5 watt output with heat sink; free-running multivibrator; and two-stage video amplifier.

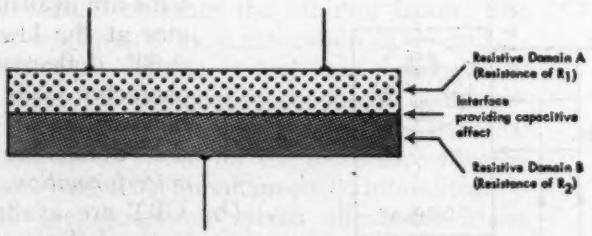


FIG. 3. SCHEMATIC of Molecular Electronic Function Block for R-C type Time Delay.

TABLE 1. LIGHT TELEMETRY Subsystem is executed using three different concepts—Numbers of components and junctions have an inverse relationship to reliability.

DESIGN CONCEPT	Volume (cu-in)	Weight (grams)	Input Power (watts)	No. of Components	No. of Junctions
Conventional Tubes and Components	4	26	5	16	18
Transistorized and miniaturized	1	7	0.75	14	15
Molecular Electronics	0.001	0.02	0.06	1	2

INCREASING COMPLEXITY of electronic equipment, made necessary by the more sophisticated capabilities required by air and space vehicles, has constantly tended to increase the size and weight of the equipment. Until recently, miniaturization of the individual components afforded the only solution to the problem of how to achieve new levels of functional capability within practical limits of weight and size.

However, miniaturization is fast approaching the reliability barrier. Although the reliability of individual components may be improved to a degree by better materials, rigid testing schedules, and stringent quality control applied in all areas of component fabrication, assembly and connections in the assembled subsystems; the probability of simultaneous successful operation of all components in any system is still the product of all the individual probabilities of each component functioning without failure.

Miniaturization techniques, in fact, increase the problems of achieving reliable connections and maintaining quality control during component fabrication and assembly, so that microminiaturized subsystems must be built with extreme precision if their failure rate is to be acceptable.

A new approach to functional design is "Molecular Electronics," as it is termed by Westinghouse. This broad concept of electronic design depends heavily on phenomena occuring within or between domains of molecules in the solid state. Some of these phenomena have been thoroughly exploited, as in the field of rectification, while others are still in the laboratory stage or may exist only as a gleam in some research scientist's eye.

However, as one accomplishment of a joint program with the Air Force to prove the feasibility of the "molelecular electronics" program, a variety of solid-state elements are now being produced that achieve entirely within themselves, results that formerly have been gained only by assembling many, varied items of electronic hardware. Instead of being considered "components", such as resistors, transistors and tubes; these elements may more properly be called "subsystems" since each of the function blocks has the ability to achieve an electronic result which is essential if all the subsystems in the overall system are to work together successfully. Function blocks perform such electronic operations as amplification, oscillation and telemetering.

Because they have no internal connections or components and need no external connections other than to couple inputs and outputs to the system, function-block subsystems should have a risk of failure (1/reliability)

equal to or less than that of familiar solid-state devices, and much less than that for a subsystem assembled from many components to achieve the same purpose.

One such unit, a light telemetering subsystem, is now being produced by the Westinghouse Semiconductor Division, Youngwood, Pa., as the youngest member in a growing family of semiconductor devices ranging from light signal diodes and transistors to heavy power transistors, rectifiers and thermoelectric systems. The circuitry requirements of one such unit, a light telemetering subsystem are given in Figs. 1A, 1B and 1C which respectively show how one such function can be accomplished by conventional tubes and components; by miniaturized solid-state and passive components, and by the molecular subsystem. Using electronic tubes, the subsystem requires 16 components and 18 soldered connections; with transistors, it still requires 14 components and 15 connections. In contrast, the molecular subsystem requires only one "component" and two connections. The illustration also suggests that power requirements are also progressively reduced in the same evolution. Table I gives comparative characteristics of the three subsystems.

Function blocks (Fig. 2) which have been developed include: (1) a 5-watt directly cascaded audio amplifier, (2) a 2-stage video amplifier, (3) a frequency selective amplifier with notch filter in a feedback loop around the amplifier structure, (4) a variety of multivibrators—bistable, monostable and astable, (5) a variable potentiometer based on the logarithmic addition of two inputs, (6) a variety of multiposition switches (including an "OR" switch, a multiple NPNP Dynistor switch, and a multiple NPNP Trinistor switch with firing electrode), (7) and analog-to-digital converter employing an NPNP relaxation oscillator, and (8) a 2-stage cooler, employing the Peltier effect, for cooling infrared detectors to proper operating temperatures.

Production of these circuits by Westinghouse is based on a very substantial knowledge of solid-state phenomena amassed over the past 30 years. It is simple now to create materials having excessive positive or negative electrical charges and, by placing these materials in physical contact with related materials, to bring about such phenomena as rectification or amplification, as in diodes and transistors. Also, we can readily take advantage of the ability of controlled nuclear radiation to cause charge paths to occur in a semiconductor material along which current will flow.

Such techniques are used to create—usually in single crystals—a number of distinct operative domains, with each domain able to sustain a desired electronic occurrence. These domains border one another at "interfaces", which are like political frontiers in their ability to initiate phenomena different from those occurring inside the molecular domains.

As a simple example in the element diagrammed in Fig. 3 we see that it is composed of two domains which meet physically at one interface. One of these domains is composed of a resistive material selected and shaped to present a resistance R_1 to the passage of current; the other domain is also resistive, but is so planned that it has a resistance R_2. At the interface, the interaction between domains causes a capacitive effect. Thus, in one tiny element we have a subsystem equivalent to a time-delay circuit.

To achieve function blocks with this capability, a number of effects and phenomena of the solid state are available. The only firm limitations on choice are that the effect must not react adversely on system reliability and must lend itself to consistent results when included in a function block. Methods typical of practice so far include: Solid-state phenomena, such as Seebeck generation, Peltier cooling, and Hall-effect multiplication; the use of PN semiconductor junctions arranged to produce a result which would otherwise require numerous individual components; and when necessary, fabrication of circuit elements within a function block. Although such phenomena will be most often used for the control of electrical signals, they will also be suitable when quantities like electromagnetic radiation, heat, and mechanical displacement are inputs or outputs.

These blocks are not assembled from various tiny components. Rather, the process starts with a basic semiconductor wafer; the necessary domains and interfaces are produced by techniques used in the production of conventional semiconductor devices, including diffusion, plating, electron beam machining, etching, cutting, radiation, alloying, and photographic processes. Although the function block so produced can now perform its function, additional processing steps are required to encapsulate the block, protect it against shock and vibration, and make it stable under the conditions of temperature and radiation it will encounter.

The essential philosophy of molecular electronics is that we can now create, modify, and process materials to endow them with the ability to accomplish electronic tasks through solid-state phenomena. The foundation of success in this new field will be the ability to develop new materials and to process available materials in new ways.

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Fairchild TA-100 Accelerometer (Type 940) is only 2½" x 1 1/16" x 1½", measures sustained accelerations from 0 to ±¼ G to 0 to ±50 G. A pendulous device, it consists of a mass supported on a torsion type spring and a precision potentiometer whose wiper is actuated by the mass. Electrical output is directly proportional to linear acceleration. Oil-filled, the damping factor is held within close tolerances through −55° to +100°C. Overall accuracy — including linearity, hysteresis and repeatability — is better than 1%.

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Rotational Speed: 0-45,000 RPM

Linear Speed: 18,000 feet per minute

Noise: Less than 100 microvolts at 45,000 RPM and 50 milliamps current

Number of Rings: Approximately 40 at 30,000 RPM

Brush Life: 50 hours at 10,000 RPM

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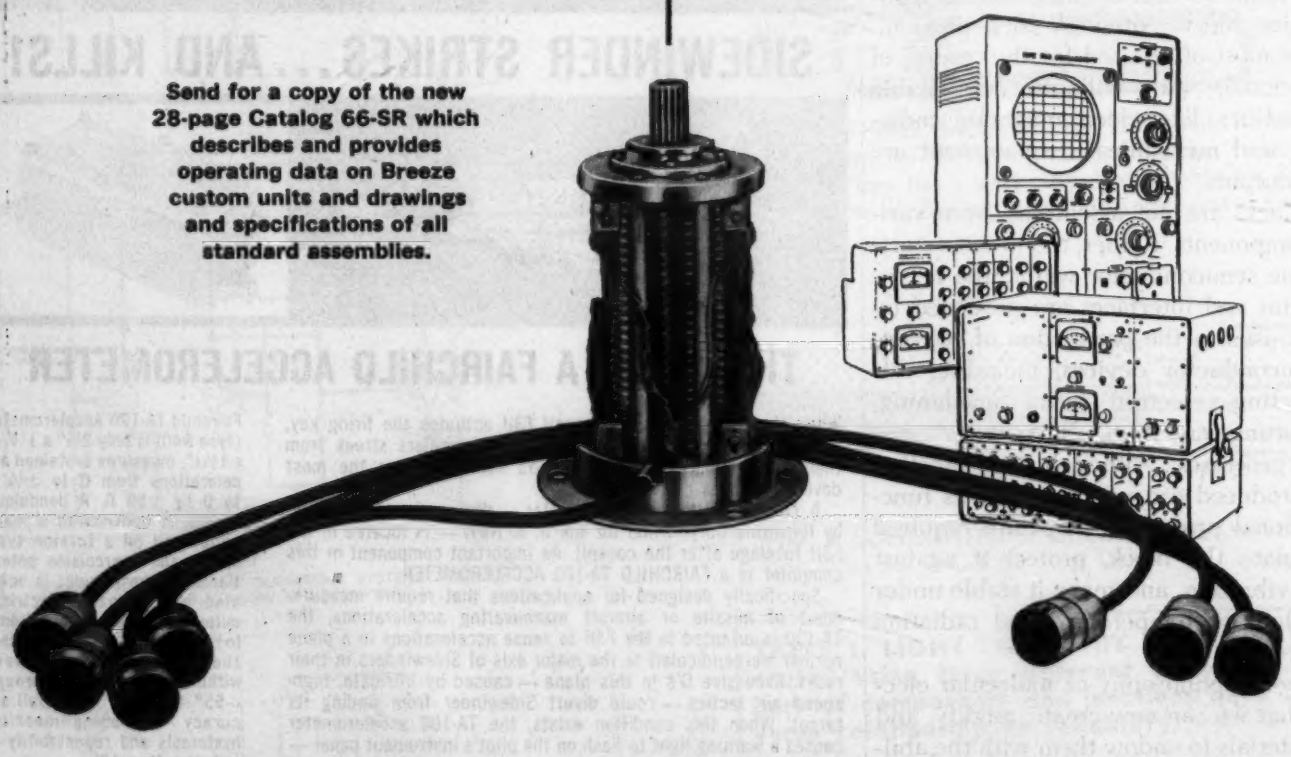
Rotational Speed: 0-5000 RPM

Linear Speed: 0-5000 feet per minute

Noise: Less than 50 microvolts at a current of 50 milliamps

Brush Life: 100 hours at 5000 RPM

Send for a copy of the new 28-page Catalog 66-SR which describes and provides operating data on Breeze custom units and drawings and specifications of all standard assemblies.



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CIRCLE 31 ON READER-SERVICE CARD

Selection of Pilot Lamp Bulbs

The pilot light must, of course, operate on the voltage available. This may be commercial line voltage (120 to 208 or 250 v) or lower voltages from step-down transformer or battery sources. If a voltage such as 6 volts is as easily obtained as the line voltage, it is always preferred for the pilot lights, lower voltage lamps being much stronger and available in a wider range of sizes, voltage and current ratings. An equally good choice is possible in lamps rated around 12 and 24 volts.

For voltages in the 110 to 250 v range, a choice between incandescent and neon glow lamps is possible.

Incandescent or Neon Glow—Factors affecting the choice are:

INCANDESCENT	NEON GLOW
High light output	Less brightness, but effective
High wattage, high temperature	Low wattage, very cool
Any lens color	Red and yellow only
Life short at overvoltage	Unaffected by voltage variation
Hot filament strength low	Extremely rugged
Require mounting hole 1" diameter min.	Mounts in 9/16" or 11/16" diameter hole.

Incandescent Lamp Characteristics: Small incandescent lamps for 120 and 250 volts must use the thinnest possible filaments, which are heated to incandescence by 40 to 50 milliamperes current. 10 watts is therefore a minimum rating for 250 volts and 6 watts for 120 volts, which requires the enclosing bulb to be at least ¾" in diameter.

Filaments for lower voltage lamps are simple, short and of lower power. Because heat is not a problem, bulbs may be smaller and filaments thicker and much stronger. Operation of tungsten lamps at ratings above and below rated values are shown in the graphs in Fig. 1. The thicker and stronger filaments of low voltage lamps are preferred when shock or vibration is a problem. Even 12-volt types are inferior in strength to 6-volt types.

Neon Glow Lamp Characteristics: Neon glow lamps, unlike the incandescent lamps, produce light essentially without heat by a gaseous electrical discharge as the gas is ionized and deionized. Since light is produced only in the red and yellow spectrum (Fig. 2), green and blue lenses are not recommended for use over any neon glow lamp.

Since a minimum voltage is needed to ionize gases, these lamps are limited to use on line voltage. If dc, the applied voltage should always exceed 105 volts with at least 160 v dc used on "high brightness" types. On dc, light is produced on only the negative electrode or cathode. When operated on ac, both electrodes glow alternately but at such a high frequency that both ap-

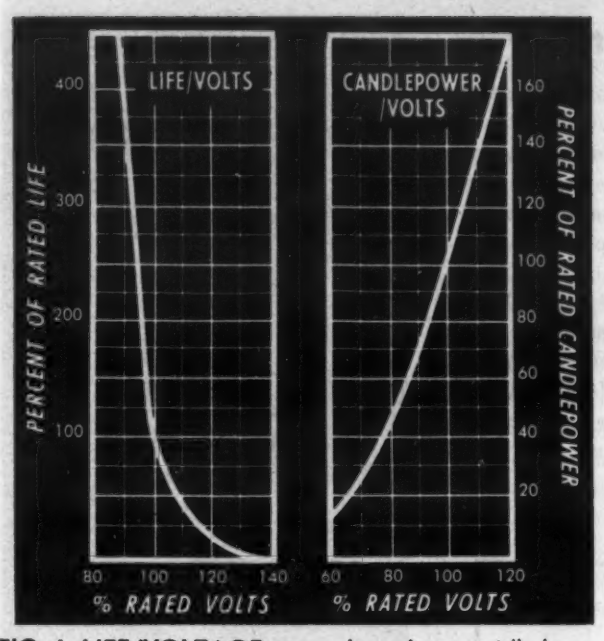

FIG. 1. LIFE/VOLTAGE curve shows how rapidly lamps fail when subjected to overvoltage. On the other hand, candlepower does not fall too rapidly on reduced voltage which becomes quite practicable in pilot light operation.

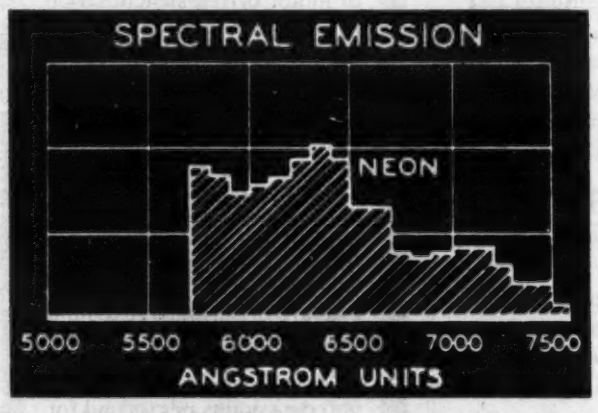

FIG. 2. SPECIAL EMISSION of neon glow lamps is only in red and yellow which are absorbed by blue and green lenses.

pear to be continuously lighted.

A minimum voltage is needed to light the neon glow lamp, but once started its resistance becomes very low so that excessive current will flow if a limiting resistor is not placed in series with the lamp. This resistor may be located in the lamp assembly, inside the base, or in the pilot light assembly. These glow lamps with screw bases do have the necessary resistor for the circuit voltage for which they are rated. Lamps with other type bases have no voltage rating as the circuit voltage is determined by the user who must also provide the necessary resistor in the pilot light assembly. (*From 256-page hard-cover "Dialco Handbook of Pilot Lights," available to qualified personnel. Dialight Corporation, 60 Stewart Ave., Brooklyn 37, N. Y.*)

TO RECEIVE APPLICATION FORM FOR THIS HANDBOOK CIRCLE 118

For engineering, for research, for business data processing in companies both large and small... **The new, fully-transistorized**

RPC-4000

ELECTRONIC COMPUTING SYSTEM

another outstanding computer value
... marketed by Royal McBee Corporation

Advanced design: fully transistorized—with important new computer design concepts that provide the largest memory, greatest problem-solving capacity and flexibility in the low- or medium-priced field. Entire system—computer, input-output typewriter and tape punch-read console—have been specially designed as a unit. **High-speed computing ability:** extra large capacity (8008 words) magnetic drum memory, with special fast access features. Computing speeds of up to 230,000 operations per minute. **Ultra high speed input-output:** 500 characters per second photoelectric punched paper tape reader, and 300 characters per second paper tape punch available as optional equipment. **Easy to use:** maximum results can be obtained by non-technical personnel. Users benefit from free training, continuing assistance, an extensive library of programs. Versatile command structure provides programming speed and flexibility. **Low in cost:** priced just above the small-scale computers, the RPC-4000 outperforms computers costing many times more. **Economical to install and operate:** no site preparation, air-conditioning or special maintenance required. Plugs into any standard wall outlet. **Multiple application ability:** designed to perform engineering, scientific and research calculations, as well as business data processing and management control functions.

The RPC-4000 is a product of the Royal Precision Corporation, and is marketed by the Data Processing Division of Royal McBee. It is the latest member of the growing family of electronic computers from the people whose LGP-30 has become the world's leading small-scale computer.

Royal Precision Corporation

Royal Precision is jointly owned by the Royal McBee and General Precision Equipment Corporations. RPC-4000 sales and service are available coast-to-coast, in Canada and abroad through Royal McBee Data Processing offices. For full specifications, write **ROYAL McBEE CORPORATION,** data processing division, Port Chester, N.Y.

CIRCLE 32 ON READER-SERVICE CARD

Will It Function...

...below ambient...above ambient?

Speed the evaluation of large components, test equipment, and rack-mounted units with Delta Design's Model 7000A Temperature Chamber. There's no waiting, no lost minutes, while a stationary oven handles other jobs. The conveniently portable 7000A offers an unmatched test-volume-to-overall-volume ratio... over 3,000 cu. in. of work space... auxiliary automatic cycling between hot-cold temperatures in the −100 to 500 F. range. Accurate to one half of one degree F., the Model 7000A offers the ultimate in dependability, convenience and space economy . . . *at a modest capital investment!*

DELTA DESIGN, INC. | SAN DIEGO | CALIFORNIA

For information, write, wire or telephone: SALES OFFICE: 7460 Girard Ave., La Jolla, Calif. GLencourt 4-1185 • TWX: La Jolla, Cal., 6453

CIRCLE 33 ON READER-SERVICE CARD

the first complete line of TRANSISTOR VOLTMETERS...

6 ALL-TRANSISTOR MIL TRVMs

- miniature, panel-mounting, for build-in applications
- power supplies included—no battery replacement or checks needed
- isolated inputs • low power consumption
- compact (as small as 2.85" diameter by 6" deep including terminals)
- lightweight • longer life

Model	Meter	Description	Price
301-1 AC TRVM	3½"	zero-left, from 10MV range	$250.00
302-1 AC TRVM	3½"	zero-center, phase sensitive, from ± 10MV	275.00
303-1 AC TRVM	2½"	50% less panel area than Model 301-1	275.00
304-1 AC TRVM	2½"	zero-center, phase sensitive, from ± 10MV	300.00
305-1 DC TRVM	3½"	zero-center, no zero-set, ± 100MV range	225.00
305-2 DC TRVM	3½"	zero-left version of 305-1, 250MV range	225.00

Note: Due to heavy demand, present delivery of most models is 6-8 weeks. For complete literature, write to Dept. MSD-8.

...where ordinary instruments are too big or inadequate.

trio

TRIO LABORATORIES, INC., Plainview, Long Island, New York
Overbrook 1-0400 • TWX HKVL 1166

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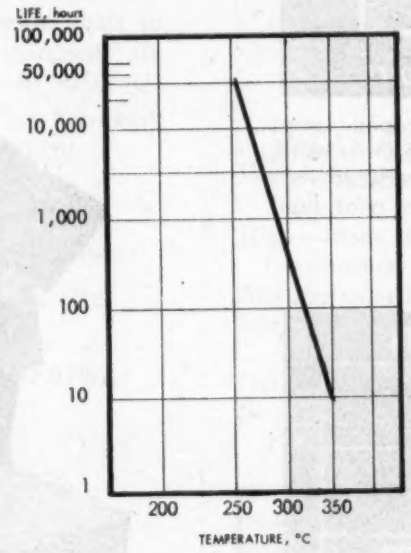
CIRCLE 34 ON READER-SERVICE CARD

Teflon Extends Wire Properties

Environmental properties of wire, including many unusual alloys and metals, are greatly extended by new Teflon® insulation. Teflon, a fluorocarbon resin, is applied to magnet wire as a water suspension. Adherence is controlled by the application of a primer coat. The primer coat developed by MECHTRON is Teflon resin with wetting agents in suspension.

Adhesion can be controlled to produce extremely tenacious coatings or free stripping insulation. After the prime coat is heat-cured, successive coats of Teflon are applied to provide a series of concentric layers as required.



SPECIAL COATING methods for applying Teflon enable continuous operation to 250°C, and for shorter periods to 350°C.

High temperature properties of Mechtron enameled wire products include continuous operating temperatures to 250°C. Considerably higher temperatures can be tolerated for shorter intervals (See Figure). This

MECHTRON ENAMELED MAGNET WIRE. Properties of typical 25 AWG wire insulated with Teflon to a .0015" wall thickness.

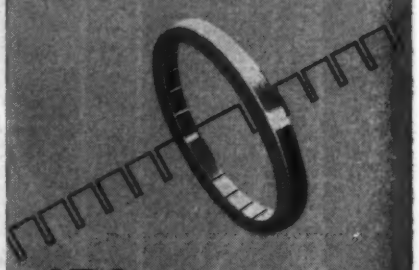
Teflon Build (Increase in Diam.)	0.0030"
Wound on Own Diameter (WOD)	OK
G.E. Scrape-Abrasion (200 g.)	40-80 strokes
Dielectric Breakdown—Dry	2000-3000 V./Mil
Dielectric Breakdown—24 Hrs. Water	1000-2000 V./Mil
Insulation Resist—Dry/24 hrs. water	25,000 Megohms
Weight loss (1000 Hrs. at 215°C)	None
Heat Shock (1)	OK
Heat Aging (2)	Good
Cut-Through Temp. (3)	325°C.
Continuity (4)	No breaks
Power Factor (60 cycles—1 megacycle	.0008-.006

Notes

1) Wound on own diameter, then baked 30 min at 215° and examined for cracking.
2) Does not crack when wound on own diameter after 1,000 hrs at 215°C.
3) The temperature of which electrical contact is made between the copper wire and the anvil or surrounding Wood's metal both under pressure of 1000 grams on three crossovers.
4) The number of breaks per 100 ft when passed through a mercury bath at a potential of 110 v ac.

®Dupont Copyright. MECHTRON is trademark of Tensolite Insulated Wire Co., Inc.

Time-Sharing Problem?



IDL MAY HAVE A SOLUTION –

Your data handling system, whether RF carrier or wire transmission line, may require time-sharing to increase its capacity and efficiency.

In the past, the advantages of motor driven switches used for multiplexing were outweighed by their disadvantages. They were smaller, lighter and simpler but, because of high contact resistance, bounce and short life, they contaminated data.

Then IDL introduced multi-fingered brushes traveling on the inner periphery of cylindrical sections to minimize resistance and bounce and extend trouble-free life to hundreds of hours. These concepts have been successfully applied to missiles in sampling 900 data points per second for more than 500 hours without signal contamination even in the milli-volt signal level ranges.

For example, Switch No. 500660 is a complete unit within a compact case, available at reasonable cost and capable of sampling up to 180 transducers. It combines 2 poles of 30 data channels with 2 poles of 60 data channels, each operating at 5 rps.

For further information, write for Technical Bulletin No. 500660; or let us propose a solution to your Time-Sharing Problem.

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INCORPORATED
Subsidiary of Royal McBee Corporation

54 MECHANIC STREET, ATTLEBORO, MASS.

CIRCLE 35 ON READER-SERVICE CARD

NEW REDESIGNED AND EXPANDED LINE OF MINIATURE OSCILLATOR CAVITIES

from 800-7000mc by
TRAK ELECTRONICS COMPANY

From its twelve years of research, development and experience with microwave oscillator cavities, TRAK now announces two new standard cavities:

(1) TRAK Type 9127-C for C-Band Pulse Service, 5400-5900 mc, pictured above.

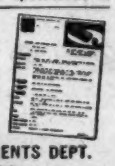
(2) TRAK Type 9127-S for S-Band Plate or Grid Pulse Service and as a CW oscillator, operating in any 300mc part of 2700-3600mc.

Other cavities engineered to customer specifications, 800-7000mc.

TRAK cavity Type 9127-C is shown above and its specifications are:

Frequency	Tunable from 5400—5900mc. Tuning done by adjusting a screw located on one end of the cavity.
Tube Type	G. E. 7486.
Power Out	Greater than 50W peak minimum over the band. (0.002 duty cycle, 1 microsecond pulse, 1000 volt pulse at approx. 0.7 amps. Higher powers obtained by using higher pulse voltages.) Depending upon the individual tube, output powers exceeding 100W peak have been obtained.
Output Pulse Rise Time	Less than 25 millimicroseconds.
Leading Edge Jitter	Approx. 5 millimicroseconds.
Temperature Stability	±0.05% from 0°C. to +71°C.
Shock	100G for 7 milliseconds in each of 3 major axes results in less than max. ±0.25mc. FM.
Vibration	15G from 50 to 2000cps. in each of 3 major axes results in max. ±1mc FM. Cavity survived 56G at 2000 cycles with less than ±4 mc FM.
Size	1" diameter x 2½" long, excluding output connector and mounting brackets.
Weight	4 ounces.
Output Impedance	50 ohms.
Output Connector	Type TNC.
Mounting	Engineered to customer specifications.

We invite you to write for TRAK Cavity Technical Bulletins.



TRAK ELECTRONICS

MICROWAVE COMPONENTS DEPT.
TRAK ELECTRONICS CO.
Division of CGS Laboratories, Inc.
54 Danbury Road, Wilton, Conn. Tel: POrter 2-5521

CIRCLE 36 ON READER-SERVICE CARD

capability has made possible the miniaturization of many wire-wound components, and has enabled designers to considerably increase the capacity of components without increasing either size or weight. Typical properties of 25 AWG magnet wire are given in the table.

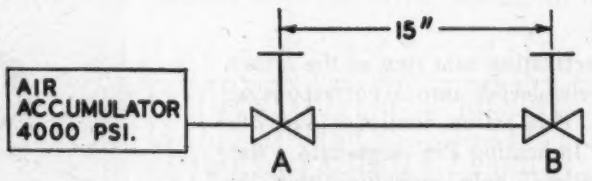
Low temperature operation down to —90°C continuous has made Mechtron insulated products extremely important in components used in Arctic installations. Specialty products, such as columbium enameled with Teflon, have been successful in far lower temperature cryogenic uses.

Low friction and chemical inertness of Teflon are typified by the use of Teflon enameled sutures for the medical profession. Low surface friction also solves difficult winding problems in electronic coil fabrications.—(*From 8-page catalog describing Mechtron Enameled Wire, Tensolite Insulated Wire Co., Inc., 1000 N. Division St., Peekskill, N. Y.*)

FOR THIS LITERATURE CIRCLE 119 ON READER-SERVICE CARD

"Dieseling" in High-Pressure Gas Systems

In high pressure gas systems it is important that the systems be completely free from lubricating oils or other combustible materials. This extreme caution is necessary because of a phenomenon known as "dieseling" about which users of high pressure air or gas systems should be aware.

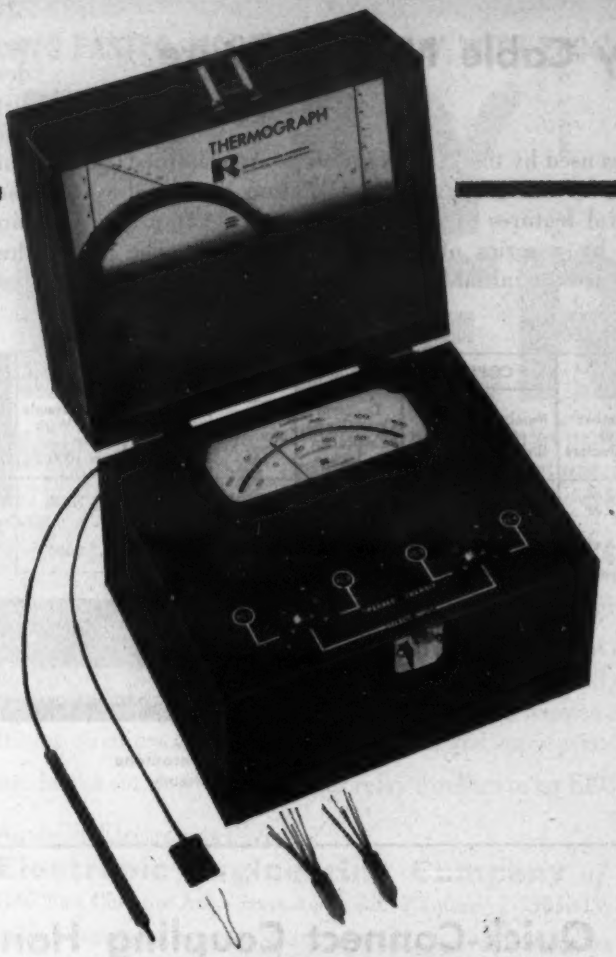


Dieseling can be demonstrated in two steps with an arrangement as simple as that shown in the sketch. In the first step, Valve A is closed and Valve B is open, venting the short section of pipe between the valve to atmospheric pressure. Then, Valve B is closed and Valve A is opened rapidly. This sudden surge of 4000 psi air, which has a density greater than balsa wood, acts like a piston, instantaneously compressing the atmospheric air in the line. The heat of compression developed will ignite any lubricating oil or combustible fumes in the line. Temperatures in excess of 1400°F have been recorded. It is obvious that extreme care is essential in order to prevent hazardous explosions.

In addition to excluding combustible materials from the system, dieseling can be checked by pressurizing the system *slowly*. Sudden release of high pressure gases should be avoided.

The valve guide in all CPV O-Seal Globe and Angle Valves is provided with expansion grooves which facilitate pressurizing the line at a controlled rate. (*From 36-page Catalog No. 60, Combination Pump Valve Co., 851 Preston St., Philadelphia 4, Pa.*)

FOR THIS LITERATURE CIRCLE 120 ON READER-SERVICE CARD



For SIMPLIFIED TRANSISTOR and DIODE TEMPERATURE MEASUREMENTS

THE NEW RESCON TRANSISTOR THERMAL TEST SET

This single, self-contained unit provides complete facilities for temperature measurement problems in designing electronics equipment. It is especially applicable for determining transistor junction temperature measurements.

Determination of heat sink efficiencies, temperature rises, thermal environmental conditions, location of "hot spots", heat transfer efficiency of transistor mounts, and thermal gradients of the overall equipment are just a few of the unlimited applications.

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ELECTRONICS CORPORATION
151 Bear Hill Road, Waltham 54, Massachusetts

CIRCLE 37 ON READER-SERVICE CARD

Navy Cable Nomenclature

All cables used by the U. S. Navy ships are classified in accordance with the type of insulation used and other general features of their construction. They are designated by a series of letters and numerals. The type letters are the initial letters of the principal words used in describing the cable, for example, Type SHFA designates a *S*ingle conductor, *H*eat and *F*lame resistant, *A*rmored cable. The letters are often followed by a "size designation" number which may have a number of different meanings, such as: (1) size of each copper conductor, expressed in thousands of circular mils; (2) the number of strands in each conductor, if shown in parens following the circular mil figure; (3) the number of conductors for multiple conductor cables; and the number of twisted pairs for telephone type twisted pair cables.

Additional examples of Navy cable designations are:

Designation	
SSGA-30	Single conductor Shipboard General use Armored, 30,860 c.m. cable.
DSGA-100	Double conductor Shipboard General use, Armored, 99,060 c.m. each conductor.
MSCA-14	Multiple conductor Shipboard for Control use, Armored, 14-conductor cable.
THFR-4	Three conductor Heat & Flame resistant, Radio cable 4,497 c.m. each conductor.
SDGA-650	Single conductor Degaussing, Armored cable, 657,600 c.m. conductor.
MDGL-19(6)	Multiple conductor Degaussing, Lead covered, 19 conductor, 6,912 c.m. each conductor.
TTHFWA-20	Twisted pair, Telephone, Heat & Flame resistant, Armored Cable, 20 pair.
TTRSA-8	Twisted Shielded pair, Radio, Armored Cable, 8 pair.

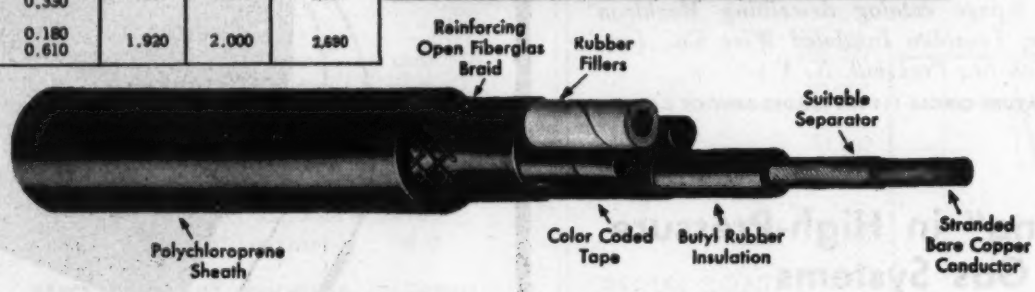
Other designations authorized under the new amendment to MIL-C-915A include MSPU (Multiple Shielded Pair, Unarmored), DDT (Digital Data Transmission) SRT (Synchro and Resolver Transmission) cables. (*From new 38-page Normandy Cable Catalog listing all Naval and AIEE-45 Spec Cables.—Normandy Electric Wire Corp., 125 Second St., Brooklyn 31, N. Y.*)

FOR THIS LITERATURE CIRCLE 121 ON READER-SERVICE CARD

Navy Type No.	Number of Conductors	COPPER CONDUCTOR: Number of Strands	COPPER CONDUCTOR: Area, Circular Mils	COPPER CONDUCTOR: Diameter Over Copper Conductor in Inches	Over-all Diameter in Inches: Minimum	Over-all Diameter in Inches: Maximum	Approximate Net Wgt. in Lb. per 1000 Ft.
FCSF-66	4 (2 of 2 of	49 133	19,800 66,370	0.180 0.330	1.300	1.370	1,300
FCSF-220	4 (2 of 2 of	49 259	19,800 220,700	0.180 0.610	1.920	2.000	2,690

Type FCSF

Four conductor, combination, special purpose, flexible cable.



Quick-Connect Coupling Handles Exotic Jet Fuels

A new standard line of aerospace tubing and hose couplings using the patented Roto Lock design is available in production sizes from ¼" through 3", with no limit in size for special designs. Materials used include aluminum, stainless steel, carbon steel and plastic.

The Roto Lock is a development of the New Products Department, Jack & Heintz, Inc., 17600 Broadway, Cleveland 1, Ohio, designed for applications in umbilical disconnect couplings for missiles, quick-disconnect, no-air inclusion coupling for drone refueling, remote control coupling for gaseous nitrogen, speed check-out for ground support components, refrigerating systems and missile fueling systems.

Field surveys among hose coupling buyers and specifying engineers have placed major emphasis on—a) ability to handle higher pressures, b) lower pressure-drop characteristics, c) longer service life, and d) the incorporation of a clear signal of coupling condition—open or closed. Other needs listed were: Greater sealing effectiveness, easier installation, higher-temperature capability and lower maintenance. Three design elements: 1) locking pin mechanism, 2) poppet design, and 3) indicating mechanism (Fig. 1) provide the Roto Lock coupling with the capability to meet all the needs expressed in the survey report.

The Roto Lock *Locking Pin* mechanism is illustrated in Fig. 2. As the operator turns the collar assembly in the "Lock" direction, the precision locking pins move along the activating cam ring of the socket, also move progressively deeper into a corresponding groove in the nipple. This action continues until the rounded head of the "Indicating Pin" seats into a flat-bottom "Locked Position" hole, signalling that the coupling is secure and locked. The coupling is easily disconnected by reversing rotation of the collar assembly.

In comparison with the forged Roto Lock locking pins, conventional quick-connect couplers use ball bearings in the locking mechanism. Under pressure conditions these balls produce indentations in the nipple body, called "brinelling". These indentations soon elongate, causing imperfect sealing, and may cause complete failure of the coupling. Brinelling, the chief cause of conventional coupling failures, Roto Lock coupling design.

The *"star" poppets*, when open, impose a minimum of restriction on fluid flow (Fig. 3). Field tests on 1" couplings place this pressure drop at less than 3.1" H_2O at 6 gpm. When closed the poppets have high self-sealing effectiveness.

The *indicating mechanism* is a simple spring-loaded pin seating in a flat-bottomed hole. In any position short of complete lock the indicating pin projects above the surface of the collar assembly where it can be *seen* or *felt*. When the coupling has reached complete lock, a click is *heard* as the pin seats in the hole.

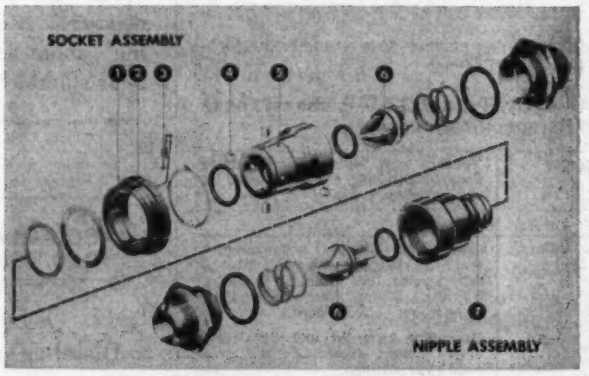


FIG. 1. EXPLODED Roto Lock Coupling showing socket and nipple assemblies. 1) Activating cam with collar; 2) collar; 3) indicating pin and spring; 4) forged locking pin; 5) flat-bottom hole seats indicating pin; 6) star poppet; 7) groove in nipple into which locking pins move.

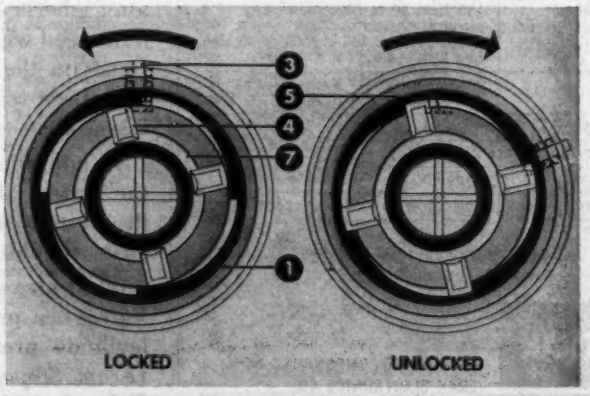
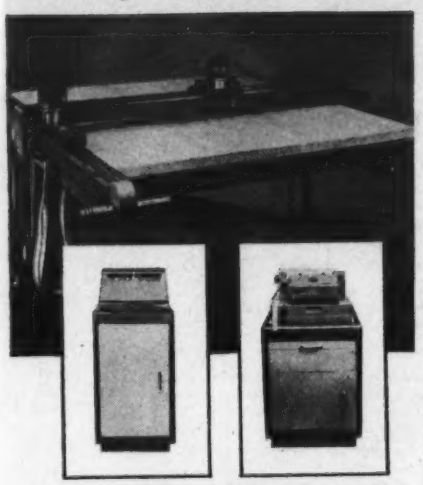


FIG. 2. LOCKING MECHANISM Operation. Numbers refer to same parts as in Fig. 1.



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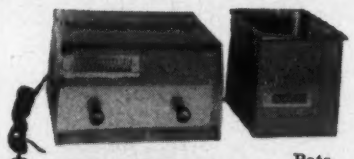

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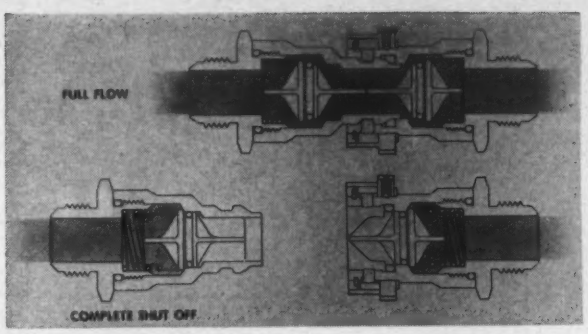


FIG. 3. SCHEMATIC of connect and disconnect conditions. Note unrestricted flow in locked position, complete shut-off in disconnect state.

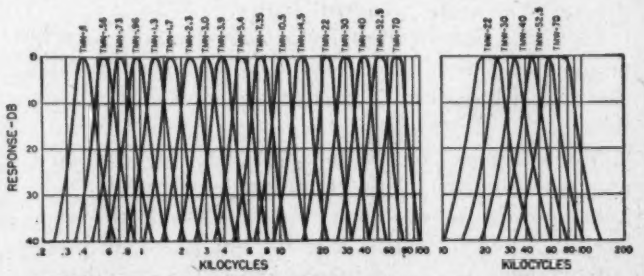
Also, the pin is now flush with the collar assembly.

Roto Lock couplings are available for service with all fluids from air through the exotic fuels. Examples are: LOX, gaseous oxygen and nitrogen, liquid nitrogen, hydrogen peroxide, inhibited red fuming nitric acid, hydrogen tetroxide, J. P. fuels, hydraulic oil, oil, steam, water, raw crude, and refrigerants.

FOR MORE INFORMATION CIRCLE 122 ON READER-SERVICE CARD

Band Pass Filters for Telemetering

A wide variety of special filters for channel separation are manufactured by the United Transformer Corporation. For comparison, one special group of noise analysis filters provides 50 channels between 4 kc and 100 kc in a total volume of 200 cubic inches. In contrast, the standard group of UTC telemetering filters with responses described in the accompanying



RESPONSE CURVES of Standard TM Filters (Typical)

curves incorporates extreme miniaturization with maximum stability, a complete set of 18 filters taking a volume of only 19 cubic inches. Both TMN and TMW types are designed for 100K input and output impedance and have an insertion loss of less than 6 db. Four-pin hermetic header, matching the small Winchester socket, is hermetically sealed to Mil-T-27A and Mil-F-18327 specifications.

TMN filters are down less than 3 db at ± 7.5% of center frequency. They are down more than 18 db at ± 25% of center frequency. Attenuation is greater than 40 db beyond 1.75 F_c and 0.58 F_c.

TMW filters are down less than 3 db at ± 15% of center frequency. They are down more than 20 db at ± 50% of center frequency. Attenuation is greater than 40 db beyond 2.5 F_c and 0.4 F_c. (*From* 16 *page catalog, "Filters and Hi-Q coils", United Transformer Corp.,* 130 *Varick St., New York* 13, *N. Y.*)

FOR THIS LITERATURE CIRCLE 123 ON READER-SERVICE CARD

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Measures voltage and current simultaneously, both pull-in and drop-out. Measures contact resistance, coil resistance, insulation resistance, pull-in and drop-out time, contact bounce. Automatic relay driving circuitry. Oscilloscope connections and appropriate circuitry.

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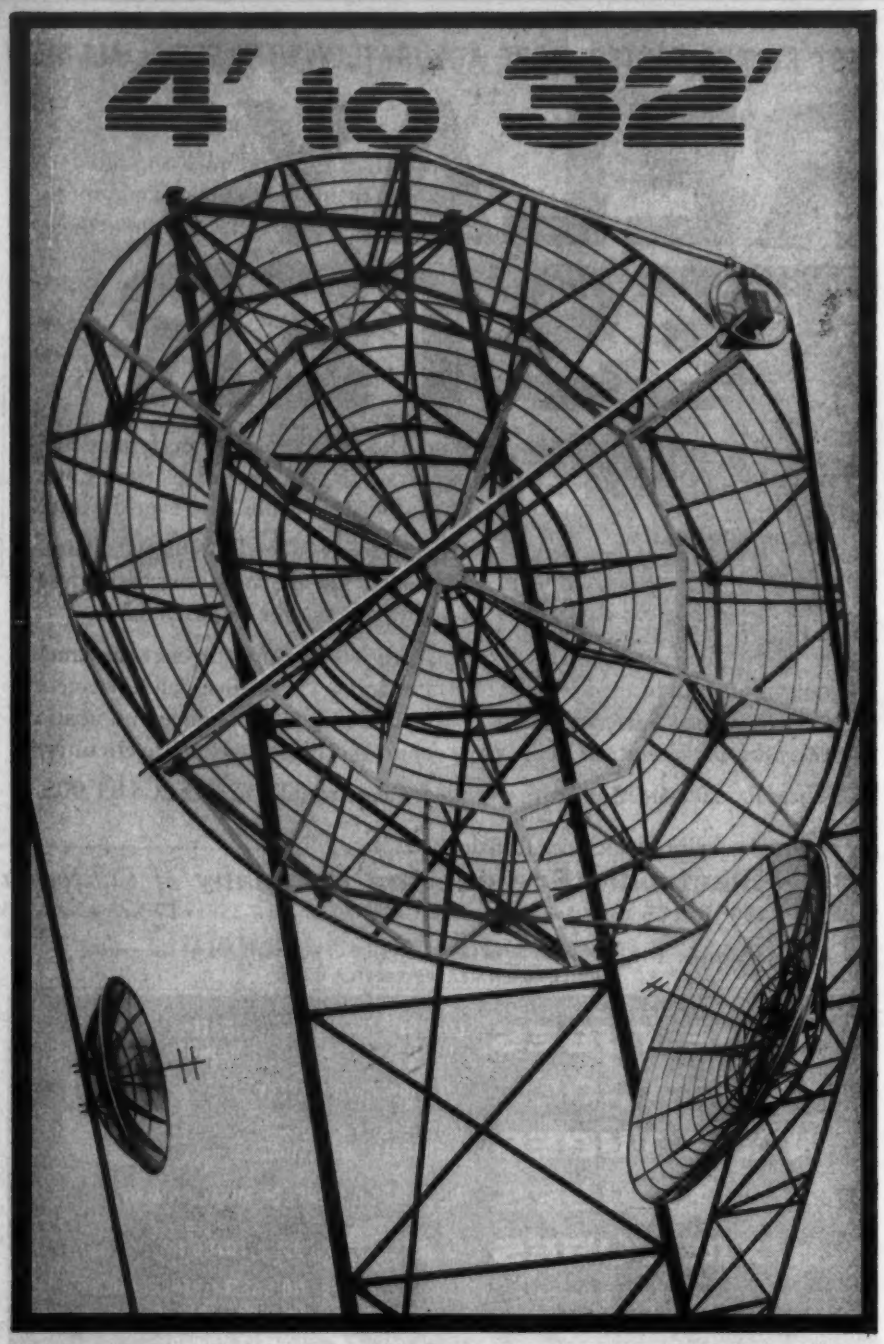
CIRCLE 41 ON READER-SERVICE CARD



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CIRCLE 42 ON READER-SERVICE CARD

Information Flow in a High-Speed Computer

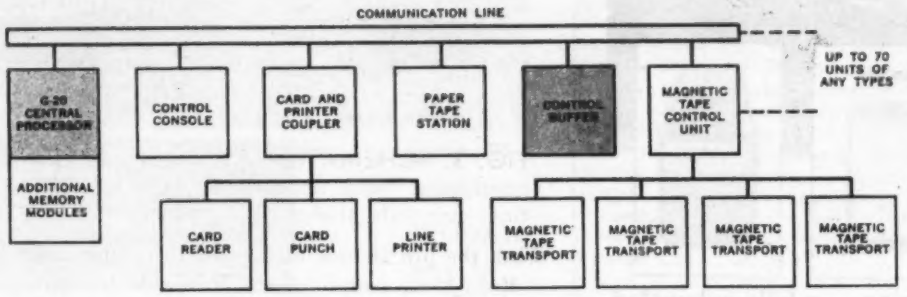

FIG. 1. DIFFERENT types of units (up to 70 in number) can attach to a single communication line. Shaded units act as communication centers for other units; additional control buffers permit additional simultaneous communications.

All types of elements in the Bendix Data Processing system attach to common communication lines. Different types of system elements and the manner in which they tie to a communication line are illustrated in Fig. 1. A line can be any desired length up to one thousand feet and can handle information at whatever rates the units attached to it operate. As many as 70 units of any types can connect to a single communication line.

Information can pass from one element on a communication line to another without passing through the central processor. Any input device attached to the line can send information to either the memory of the central processor or to a control buffer on the line. Any output device attached to the line can receive information from the memory of the central processor or from a control buffer.

In Fig. 1, information from magnetic tape may be tabulated by the printer, via the control buffer, while the central processor is performing internal computation.

Multiple pairs of input-output elements can communicate concurrently. Input-output elements communicate with other under control of a central processor or a control buffer. Additional pairs of input-output elements can communicate with each other at the same time by adding control buffers to the system.

A single communication line handles a number of messages at the same time by automatic multiplexing of the messages. Additional communication lines are added when necessary via the control buffers. Two communciation lines can receive information from an element on one line and send it to an element on the other line.

In the system in Fig. 2, high speed elements are attached to the central processor's communication line; low speed elements are attached to the control buffer's other communication line. Central processor time is conserved since all direct input-output operations occur at high speed. With the proper combinations of equipment, input-output can be effectively off-line or on-line, the selection being made under program control. (*From 24-page "Technical Introduction to the Bendix G-20 System," Computer Division, The Bendix Corporation, Los Angeles 45, Calif.*)

FOR THIS LITERATURE CIRCLE 124 ON READER-SERVICE CARD

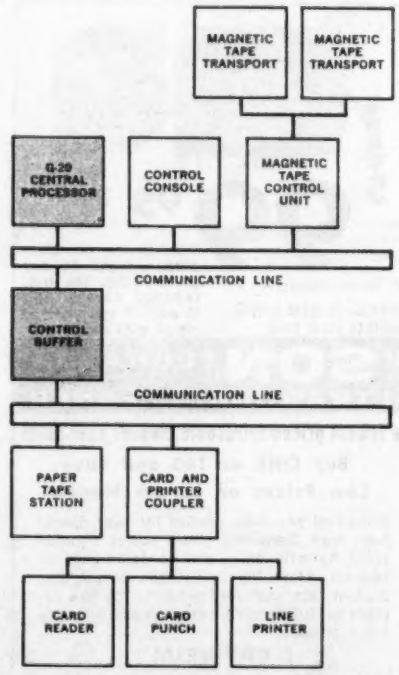

FIG. 2. HIGH SPEED UNITS are on one communication line with low-speed units on second line under control of a control buffer in this system. Other arrangements allow off-line or on-line operation from the same elements at the user's option.

Compact New Stub Stretcher

Adapts to Wide Frequency Range

The stub stretcher is an impedance matching device capable of matching any value of impedance. The only limitation to such transformation is the travel of the contacts and resistive loss within the tuner.

The conventional stub stretcher is shown in Fig. 1. Any load admittance Y_L is transformed by the line stretcher such that it appears at the stub as $Y_o \pm jB$, where Y_o is the characteristic admittance of the system and B is any value of susceptance. The stub is then adjusted to provide a susceptance of magnitude equal to B but of opposite phase. The line is then matched.

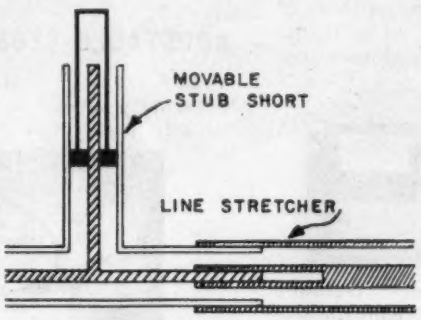

FIG. 1. STUB STRETCHER (conventional) consists of line stretcher capable of extending one-half wavelength, and variable stub of one-quarter wavelength; or a line stretcher extension on one-quarter wavelength and a stub one-half wavelength long.

In order to match all impedances, either the line stretcher must be capable of one-half wavelength of travel and the stub of one quarter wavelength, or the stub of a half wavelength of travel and the line stretcher of one quarter wavelength.

The new Microlab Type SL stub stretcher is shown schematically in Fig. 2. The center conductor of the main line is broken to provide the line stretcher. The outer conductor of the stub is slotted, permitting adjustment of the short position without increasing the overall dimensions of the tuner. A movable slider outside the stub positions the short contained within the stub. Radiation from the slot is negligible.

The SL stub stretcher design provides compact tuning, with the folded line stretcher capable of a full half-wavelength of travel although it is only one quarter wavelength long. The stub travel is accomplished within the same quarter wavelength.

Locking caps are provided (Fig. 3) to adjust sliding tension and to lock desired settings. Beryllium copper contact springs are employed, assuring long life and noise free operation. Internal stops prevent damage to contacts and accidental disassembly of the tuner.

Available in two frequency ranges, 300-to-10,000 mc and 1000-to-10,000 mc, the SL stub stretchers have the following characteristics: Max insertion loss, 0.2 db; impedance, 50 ohms; average power, 100 watts; temperature range, —55°C to 150°C; and meet environmental requirements of MIL-E-5272B. They are normally supplied with one male and one female connector in N, BNC, TNC, C or HN types. (*From 12-page catalog 9D, Coaxial Tuners, Microlab, 570 W. Mt. Pleasant Ave., Livingston, N. J.*)

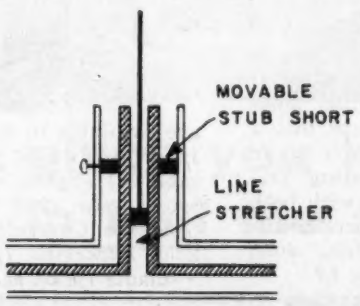

FIG. 2. STUB STRETCHER (Type SL) uses folded line stretcher formed by broken center conductor and movable stub short, both only one-quarter wavelength long, physically.

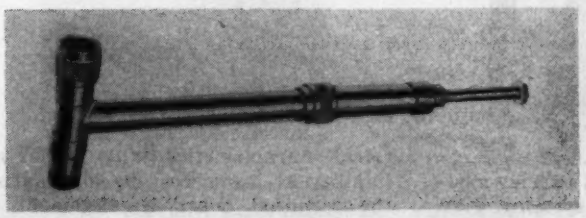

FIG. 3. LOCKING caps adjust and lock sliding beryllium copper contacts.

FOR THIS LITERATURE CIRCLE 125 ON READER-SERVICE CARD

CIRCLE 43 ON READER-SERVICE CARD →

...*for* MINIATURIZATION

NEW! miniature BALL BUSHINGS for LINEAR MOTIONS

LOW FRICTION and WEAR
LASTING PRECISION ALIGNMENT
ELIMINATE BINDING and CHATTER
ZERO SHAKE or PLAY
LONG LIFE — LOW MAINTENANCE
SOLVES SLIDING LUBRICATION PROBLEMS

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Various types of* BALL BUSHINGS *are made for shaft sizes from 1/8" to 4"... with small sizes available in Stainless Steel. Write for literature and name of our representative in your city.

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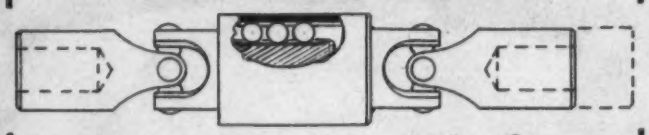
TELESCOPING MINI-JOINTS ZERO BACKLASH



Part No.	*Bore	Body	Length Closed	Torque In. Oz.
T1BS	.0938	3/16	17/16	16
T2BS	.125	3/16	17/16	16
T4BS	.1875	9/32	2	64
T6BS	.250	3/8	2 1/2	256

*Bore Limits + .0005 — .0000
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Our new telescoping miniature universal joint assembly offers the following features.

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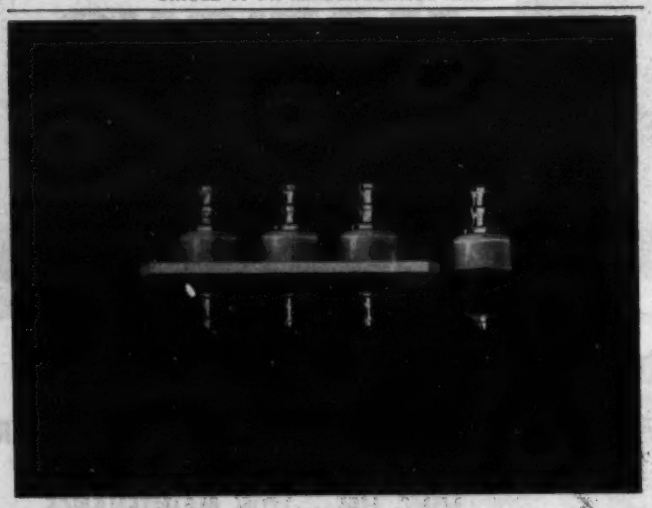

New single-unit, non-turning, hermetic terminal cuts installation costs in *HALF!*

- Voltage range — 1500V operating
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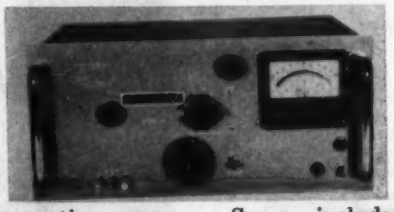
SMD new products

SERVO SYSTEM

AUTOPILOT INPUT SIMULATOR

New System Error Bridge provides test signals for flight control systems. Angular inputs, accurate within 20 seconds of arc, replace such transducers as the vertical gyroscope and



magnetic compass. Specs include: Range 0° through 360° continuous; resolution, 4 sec-of-arc; size, 19" x 10½" x 8".—*Theta Instrument Corp.*, 520 *Victor St., Saddle Brook, N. J.*

CIRCLE 126 ON READER-SERVICE CARD

PRINT-CKT CHOPPER

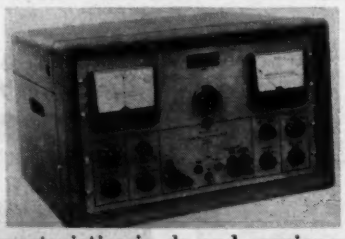
New hermetically sealed miniature chopper package for printed board application for low level signal application in military and commercial equipment, operates over tempera-

tures from —55°C to 125°C, and in shock to 50 G and vibration of 30 G from 10 to 2000 cps. Residual noise is less than 15 uv at 400 cps into 1 megohm, and thermal noise is at an extremely low level. Operating frequencies from 1 to 500 cps with both MRB and BBM switching are available.—*James Electronics Inc.*, 4050 *N. Rockwell St., Chicago* 18, *Ill.*

CIRCLE 127 ON READER-SERVICE CARD

SERVO ANALYZERS

New Series 400 Controls Analyzers, providing in one package all necessary functions for rapid and accurate determination of response



characteristics in dc and carrier-modulated feedback control systems, give accurate results even with semiskilled operators and little supervision, Fundamental phase and amplitude system response to the output of a self-contained signal generator is quantitatively measured by a manually operated phase dial and a direct reading output meter. Although a scope is not required, a sawtooth sweep voltage and output signal connections are provided for those applications where a scope display is desired.—*Superior Manufacturing and Instrument Corp.*, 154-01 *Barclay Ave., Flushing* 55, *N. Y.*

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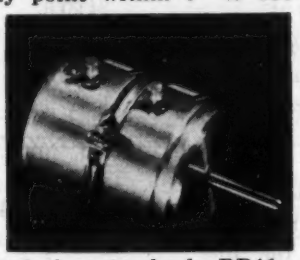
ADUSTABLE SEGMENT SWITCH

New rotary switch that can be externally adjusted to open or close at any point within 0° to 355° are

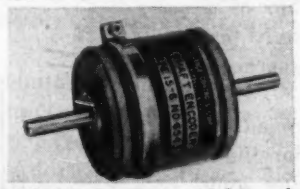


enclosed in standard RR11 servo mount housing. Passes MIL environmental requirements, has voltage breakdown of 1000 v ac.—*Precision Line Incorporated*, 63 *Main St., Maynard, Mass.*

CIRCLE 129 ON READER-SERVICE CARD

SHAFT ENCODERS

New Analog-to-Digital GSE-15 Shaft Encoders, featuring highest reliability, long life and high, accuracy

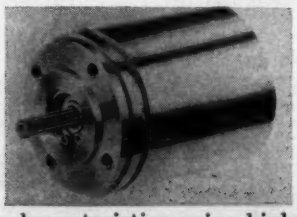


are available in 6- to 10-bit, also 13, 15, 17 and 19-bit models. Meet applicable MIL-Specs, show no appreciable brush wear after 30-million cycles.—*Guidance Controls Corp.*, 110 *Duffy Ave., Hicksville, L. I., N. Y.*

CIRCLE 130 ON READER-SERVICE CARD

SERVO MOTOR

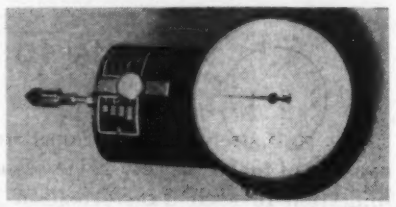
New —55° to 125°C Size 11 servo motor which is shorter, lighter, more reliable and less costly than BuOrd Mark 14 type but with the same elec-



trical characteristics gains higher reliability at lower cost by eliminating the terminal board arrangement of BuOrd Mark 14 and utilizing lead wires.—Designed for 400 cps airborne and ground control applications.—*John Oster Manufacturing Co., Avionic Div., Racine, Wisc.*

CIRCLE 131 ON READER-SERVICE CARD

HAND TACHOMETER

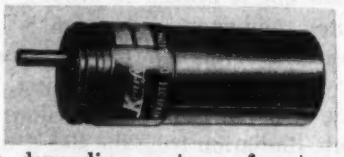


New Model HT-12 four-range Hand Tachometer, centrifugal type, has stop-button feature to retain readings on dial until released. Measures rpm as well as ft/min. Total Range: 90 to 12,000 rpm, divided into four separate ranges: 90-360 rpm; 300-1200 rpm; 900-3600 rpm; and 3000-12,000 rpm. Accuracy is ½ of 1%.—*Kernco Instruments, Inc., Box* 1284, *Church St. Station, New York* 8, *N. Y.*

CIRCLE 132 ON READER-SERVICE CARD

SIZE 8 GEARED SERVO

New Model M327-001 Size 8 Geared Servo Motors are now available in centered-shaft gearheads in 28 ratios from 7.62:1 to 1254:1, and in eccentric shaft gearheads in ratios from 7.62:1 to 903:1. Typical characteris-

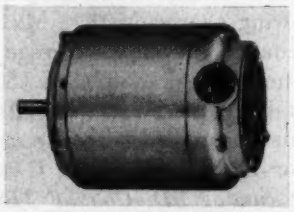


tics, depending on type of motor and gearhead combination used, include: Noload speed, 4.7 to 773 rpm; minimum stall torque, 1.8 to 20 oz-in; backlash (max), 30 to 45 minutes of arc; weight 3 oz.—*Kearfott Division, General Precision Incorporated*, 1150 *McBride Ave., Little Falls, N. J.*

CIRCLE 133 ON READER-SERVICE CARD

SYNCHRONOUS STEPPING MOTOR

New Type SS150M Slo-Syn Motor for driving beacons, searchlights, radar antennas and similar duty pro-

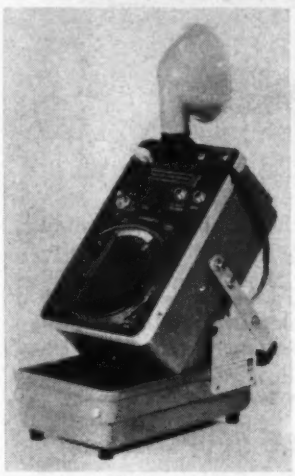


vides a torque of 150 oz-in and a speed of 72 rpm on 60 cycles. Its instant stop, start and reverse characteristics when driven by dc also make it a versatile "inching" motor. Standard types with special planetary gear assemblies provide speeds of 16.6, 3.3, 0.67, 0.133 or 0.027 rpm.—*The Superior Electric Company, Dept SS, Bristol, Conn.*

CIRCLE 134 ON READER-SERVICE CARD

STROBE TACHOMETER

New Strobotac® Type 1531-A, features powerful Strobotron lamp which emits up to 7 million peak candlepower in flashes only 1 to 6 μsec in duration, allows measurement and study of machine speeds up to 250,000



rpm, even in brilliantly-lighted areas. Other WESCON exhibits will include measurement of semiconductor capacitances of 1 or 2 pf, also Bridge for R,L and C parameters of tunnel diodes at UHF.—*General Radio Co., West Concord, Mass.*

CIRCLE 135 ON READER-SERVICE CARD

ELECTRIC COUNTER

New solenoid-driven Model 6-Y-1-RMF electric counter with a life rating of 30,000,000 counts at a speed of 1,000 cpm, has a compact built-in

rectifier for operation from ac. Can be placed remotely from a contactor actuated by the operation being counted.—*Durant Mfg. Co.*, 1914 *No. Buffum St., Milwaukee* 1, *Wisc.*

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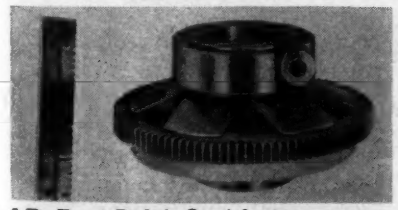
NON-GALLING CLUTCH

New Dynaco slip clutch can be set to a predetermined torque which remains uniform even after extended periods of slipping. Friction plate is



of DuPont Delrin® with gear mounted on ball bearing and stainless steel bushings.—*Dynamic Gear Co., Inc., Dixon Ave., Amityville, L. I., N. Y.*

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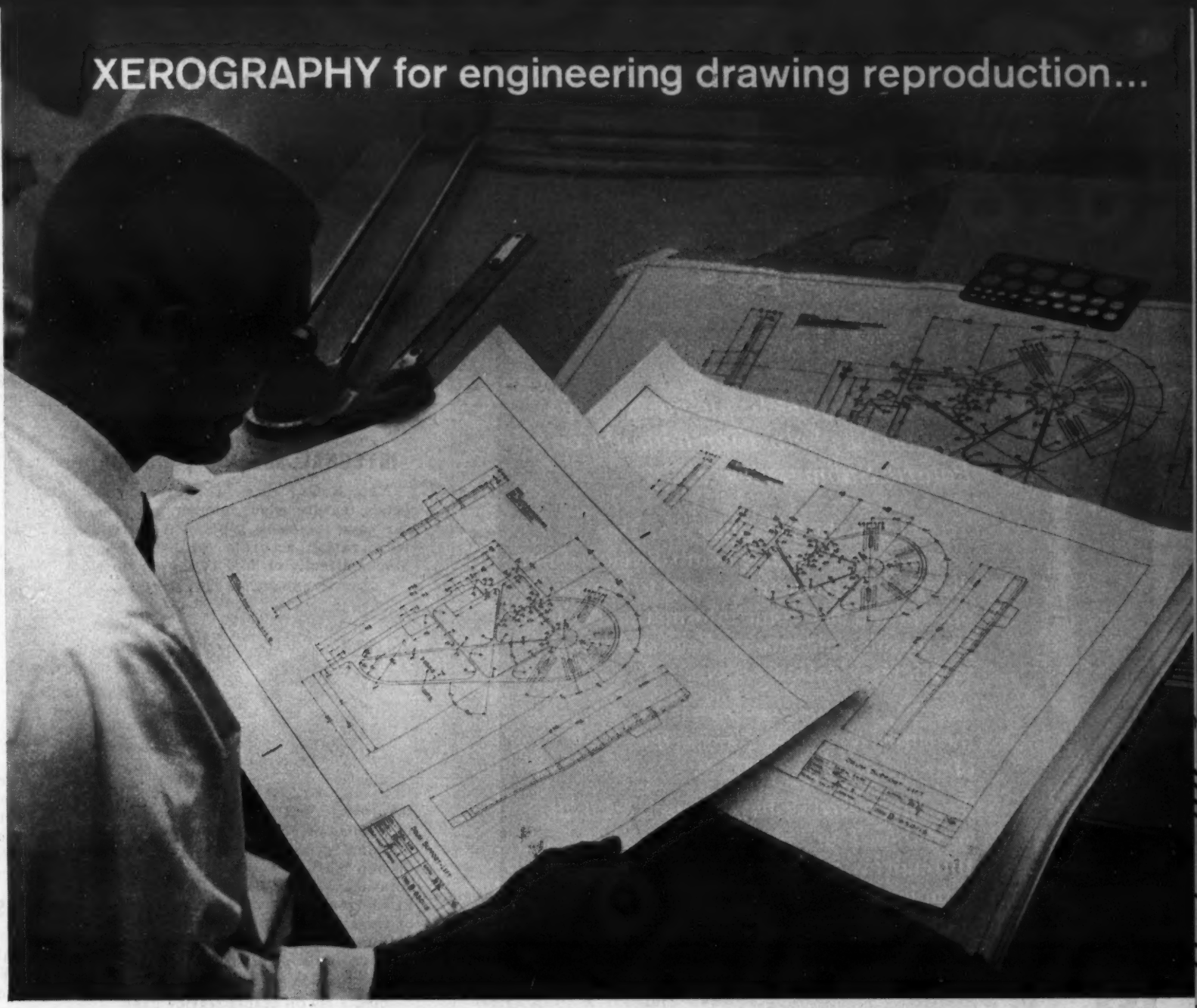
XEROGRAPHY for engineering drawing reproduction...



. . . gives you high-quality engineering prints in half the time, at remarkable savings!

Xerography is the fast, clean, dry, electrostatic copying process that has revolutionized engineering drawing reproduction! Many of the nation's leading industrial firms now use Haloid Xerox copying equipment . . . with reported savings from $20,000 to $500,000 a year! And, all XeroX equipment is available to you, without capital investment, at modest monthly rentals.

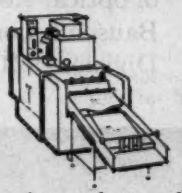
For high quality offset paper masters:

XeroX® Model 1218 copying equipment combines with offset duplicating . . . and the results are spectacular! This equipment prepares sharp, inexpensive paper masters from original drawings of A to D size. The larger drawings are perfectly reduced to 12" x 18" masters, from which multiple prints can be run off in seconds!

Volume reproduction from original drawings or roll microfilm: Just push a button

on the XeroX Copyflo® Continuous Printer for sharp, dry, ready-to-use prints (on ordinary paper, vellum or offset paper masters up to 11" wide). Prints are made at the rate of 20' a minute. Copyflo printers enlarge, reduce or copy size-to-size from original drawings or roll microfilm (16 or 35mm).

Reproduction from card-mounted microfilm: The XeroX Copyflo 24 C and the exciting new Copyflo 1824 automatically produce dry, positive prints on ordinary paper, vellum or offset paper masters from 35mm card-mounted microfilm! The Model



24C produces ready-to-use prints (up to 24" x 36") at the rate of 20 linear feet a minute! The new Model 1824 for small volume users or large, decentralized users, produces prints from 8½" x 11" to 18" x 24".

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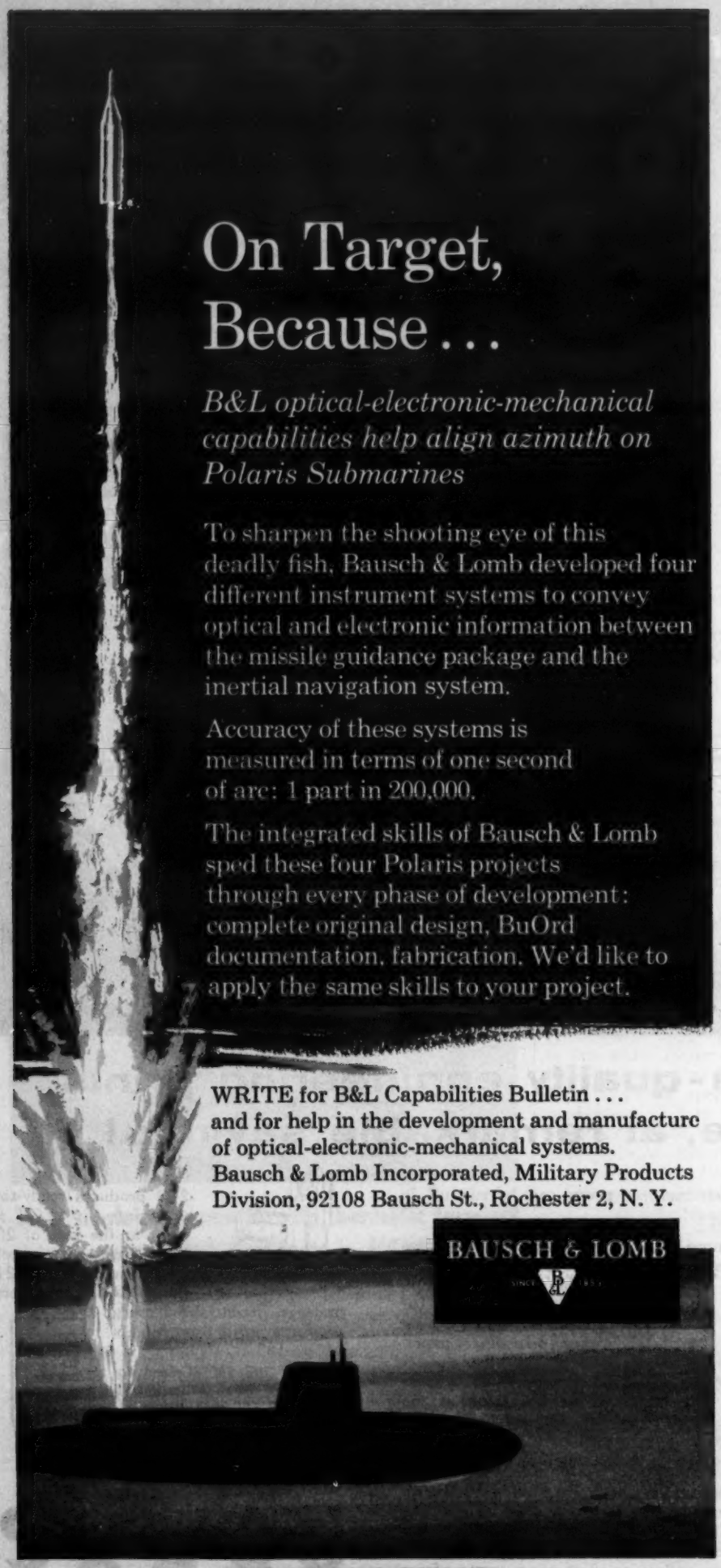
HALOID XEROX


On Target,
Because . . .
B&L optical-electronic-mechanical capabilities help align azimuth on Polaris Submarines
To sharpen the shooting eye of this deadly fish, Bausch & Lomb developed four different instrument systems to convey optical and electronic information between the missile guidance package and the inertial navigation system.
Accuracy of these systems is measured in terms of one second of arc: 1 part in 200,000.
The integrated skills of Bausch & Lomb sped these four Polaris projects through every phase of development: complete original design, BuOrd documentation, fabrication. We'd like to apply the same skills to your project.
WRITE for B&L Capabilities Bulletin . . . and for help in the development and manufacture of optical-electronic-mechanical systems.
Bausch & Lomb Incorporated, Military Products Division, 92108 Bausch St., Rochester 2, N. Y.
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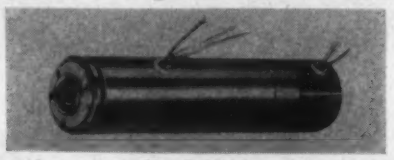
CIRCLE 47 ON READER-SERVICE CARD

MOTOR-INTEGRATING TACHOMETER

Design of new size 10 motor-integrating tachometer provides scale factor of 2.5 v/ 1000 rpm, a rotor moment of 3 gm-cm² and an accel-

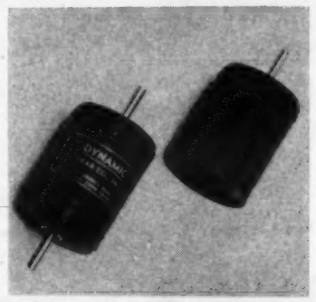


eration at stall of 9500 rad/sec². Operates over a temperature range of —55°C to 125°C with a linearity from 0-3600 rpm of ±0.12%.—*Eclipse-Pioneer Div., Bendix Corporation, Teterboro, N. J.*

CIRCLE 138 ON READER-SERVICE CARD

INTEGRAL SPEED REDUCERS

New BuOrd Size 11 Frame gearheads feature whole-number gear ratios and postless type construction with ratios accurate within 0.5%. Mount directly on MK 14 servomotors

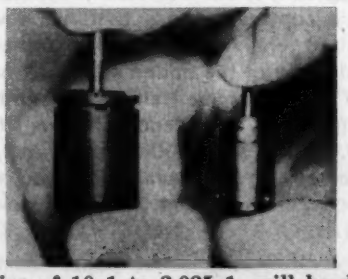


to provide 190 stock ratios from 7:1 to 5950:1. Output torque, 75 oz-in; starting torque, 0.005 oz-in; backlash, 30 min max; either direct or opposite rotation and lubricated for life operation from —55° to 100°C are a few of the salient specs. Stock units available in 2 weeks, maximum.—*Dynamic Gear Company, Inc., Dixon Ave., Amityville, N. Y.*

CIRCLE 139 ON READER-SERVICE CARD

MICROGEAR CHAMP

"Smallest" size five gearhead unit is compared with size eight unit, formerly the world's smallest transmission. New unit, capable of speed

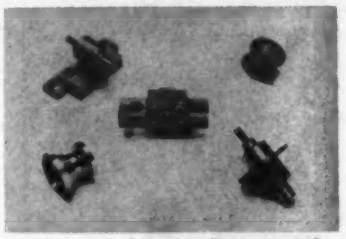


ratios of 10:1 to 2,025:1, will be displayed at WESCON Booth #765. It is planned for use in advanced satellite systems.—*Bomar Instrument Corp.*, 8000 *Bluffton Rd., Ft. Wayne, Ind.*

CIRCLE 140 ON READER-SERVICE CARD

BEARING ASSEMBLIES

New service for manufacturers of instrument assemblies is provided by new facility designated ROTASSEMBLY Division. Evaluation and costing of designs for manufacturer are

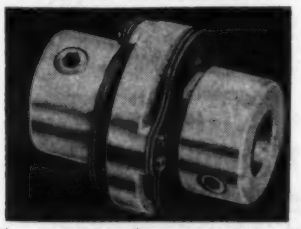


done at no charge by experienced engineers. Tests and assembly equipment is same as used in producing New Hampshire bearings to ABEC 7 and better tolerances.—*New Hampshire Ball Bearings, Inc., Peterborough, N. H.*

CIRCLE 141 ON READER-SERVICE CARD

FLEXIBLE COUPLINGS

Maximum flexibility with zero backlash is provided by new coupling design using aluminum with



beryllium copper leaves in ½", ¾", 1" and 1½" dia units for torques from 4 to 500 oz-in max.—*Naugler Engineering, Inc.*, 19 *Madison Ave., Beverly, Mass.*

CIRCLE 142 ON READER-SERVICE CARD

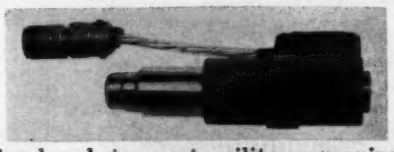
SERVO VALVE/ACTUATORS

New Flight Control Tandem Servo Valves and Actuators for 4,000 PSI, 275°F service, have a one-piece sleeve and one-piece spool machined to reproduce identical flow characteristics in two separate hydraulic systems, which guarantees that factory set synchronization will be unaltered during service use.—*Hydra-Power Corp., Pine Court, New Rochelle, N. Y.*

CIRCLE 143 ON READER-SERVICE CARD

"HAMMER-BLOW" ACTUATOR

Miniature actuator providing mechanical power for emergency operation of switches, valves, fire protection apparatus and other uses was



developed to meet military requirements, is now available for industrial and commercial applications. Manual AB is available for complete information.—*Electro-Seal Corp.*, 946 *A North Ave., Des Plaines, Ill.*

CIRCLE 144 ON READER-SERVICE CARD

DISPLAY SYSTEMS

HIGH-FREQUENCY SCOPE TUBE

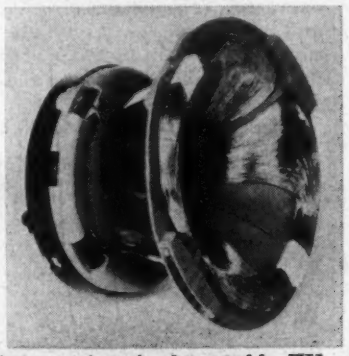
New Type K1931 5¼" CRT which permits high-frequency operation and sensitivity for general purpose oscilloscopes is said to be the first 5"

type tube with post-acceleration for use in low frequency scopes. Tube operates at screen potential of 5,000 v with deflection factors of 25 to 35 v/ inch comparing with screen of 3,000 v and 30 to 50 v/inch for the standard 5ADP tube.—*Allen B. Du Mont Laboratories, Inc., Clifton, N. J.*

CIRCLE 145 ON READER-SERVICE CARD

NEW TV YOKE

A new type, super-sensitive TV yoke which operates on less power for deflection circuits, saves battery pow-

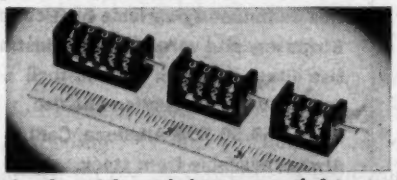


er in transistorized portable TV sets, reduces associated component ratings in other display devices using cathode ray tubes.—*Sickles Div., General Instrument Corp., Chicopee, Mass.*

CIRCLE 146 ON READER-SERVICE CARD

SUB-MIN COUNTER

New "S" series of sub-miniature (½" wheel) instrument counters are designed for use in missile tracking devices, radar equipment, navigation instruments, computors, and similar instruments where speeds to 2000 rpm and accurate counts must be ob-

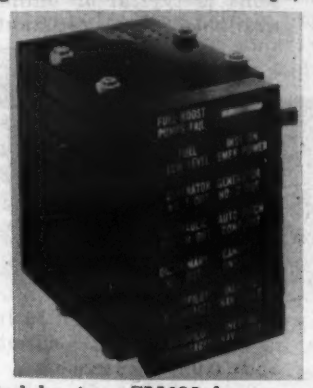


tained with minimum weight and space. 3, 4, and 5 figure instruments are standard, with additional figures or special combinations available on order.—*Durant Mfg. Co., 1949 No. Buffum St., Milwaukee 1, Wisc.*

CIRCLE 147 ON READER-SERVICE CARD

MINI ANNUNCIATOR

New multi-channel illuminated annunciator consists of a bank of light boxes each containing two separately energized nomenclature strips, each

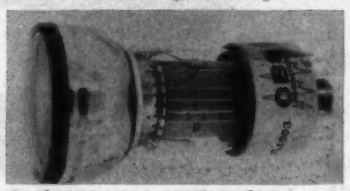


lighted by two CM683 lamps operating at 9 volts. Legend is visible only when corresponding channel is energized. 14-channel assembly shown is 3.5" high, 2.35" wide and 3.6" deep, weighs 1.5 lbs.—*Radar Relay, Inc., 2322 Michigan Ave., Santa Monica, Calif.*

CIRCLE 148 ON READER-SERVICE CARD

PHOTOMULTIPLIER TUBE

New CL-1003, 3" dia end-on 10-stage photomultiplier tube has a plano-concave faceplate with S-11 photocathode (visible response) deposited on a curved-surface to ensure excellent uniformity of response. The

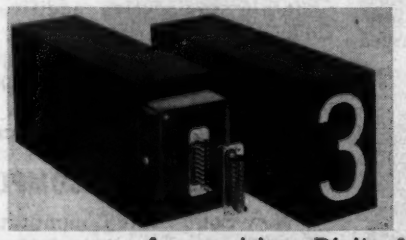


result is an extremely short transit time spread and very high photo-electron collection efficiency. A companion tube, CL-1002, with 2" dia faceplate, is also available.—*Electron Tube Dept., CBS Laboratories, High Ridge Rd., Stamford, Conn.*

CIRCLE 149 ON READER-SERVICE CARD

PLUGIN DIGITAL READOUT

New Series 80000P Digital Readout permits quick servicing without disturbing the internal wiring of system, also eliminates need for rear

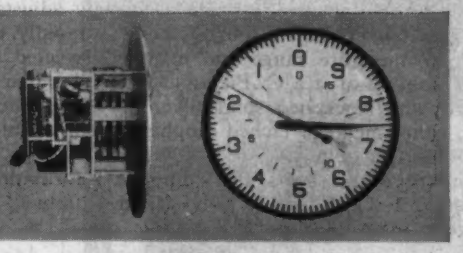


access space for servicing. Digits 0 through 9 are 3¾" high, are rear-projected onto front viewing screen, readable from any angle of view.—*Industrial Electronic Engineers, Inc., 5528 Vineland Ave., No. Hollywood, Calif.*

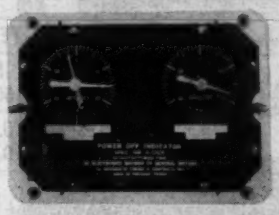
CIRCLE 150 ON READER-SERVICE CARD

MIL-SPEC TIMERS AND PICK-OFFS

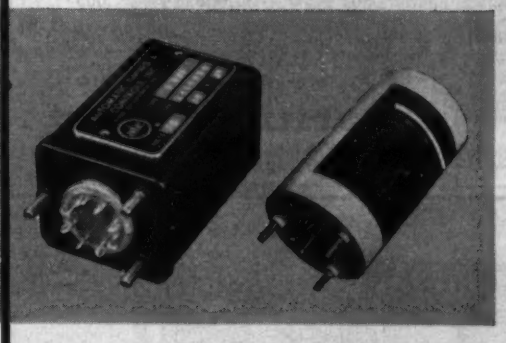
Countdown Controllers accurately show split-second, continually corrected visual missile countdown sequence. Electrically synchronized with actual count.



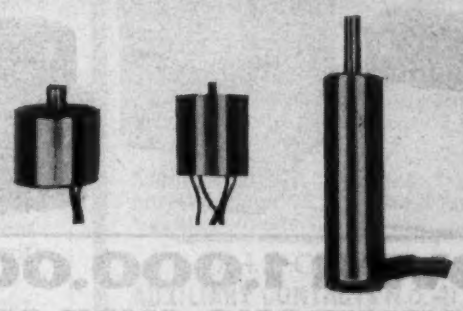
Elapsed Time Indicator gives visual check of power interruptions. Tied in with missile power supply from final assembly to launching. Records length of individual interruptions and total time off.



Transistorized Time Delay Relay (left) controls timing intervals from 50 milliseconds to 5 minutes. Made in 72 forms. **Hermetically Sealed Delay Timer** (right) provides fixed or adjustable time delay for repeat and reset cycle delay timing and sequencing for missiles or ground support equipment.



Atcotran Differential Transformers are electromechanical transducers for measuring linear motions. Three ATC mil-spec approved types, 6210-K (left) 6207-K (center) and 6203-K (right) give unprecedented reliability as displacement pick-offs for altimeters, pressure cells, servo feed-back signals, etc.



Send for your free Condensed Catalog "Automation Components and Control Systems"—today!

ATC can supply all kinds of differential transformers, timers, pick-offs and other related mil-spec components—designed and engineered to the most stringent specifications. Extensive research and development is constantly increasing reliability, design compactness and circuit simplicity to meet ever more exacting air and ground requirements.

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KING OF PRUSSIA, PENNSYLVANIA

A Subsidiary of American Manufacturing Company, Inc.

ATC, Div. of Interprovincial Safety Industries, Ltd., 5485 Notre Dame St., West, Montreal 30, Quebec

CIRCLE 48 ON READER-SERVICE CARD

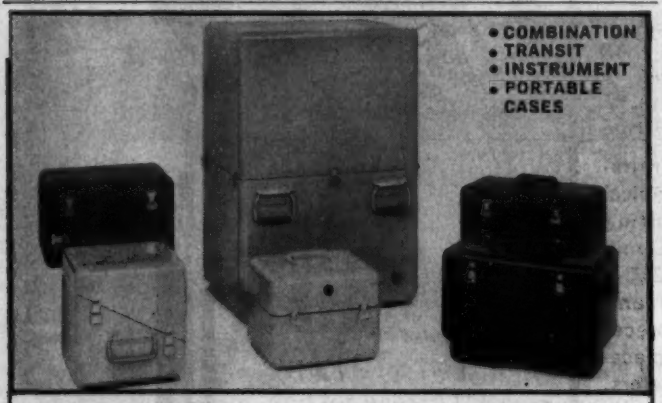
Infrared Sources from Perkin-Elmer

Perkin-Elmer infrared sources, when used with a PE 521-5 Temperature Controller, provide accurately adjustable sources of IR radiation. These PE sources warm up rapidly, operate over a wide temperature range and maintain selected temperature with a stability of ±1°C. Emissivity of better than .99 is provided by the blackened solid silver core. Individual aperture plates, either metal or etched sapphire, are available within the range indicated below.

Write for data sheets and complete information on these and other Perkin-Elmer IR physical measurement instruments and components.

	PE 521-1	PE 521-4	PE 521-6
Temperature Range	200°C–600°C	50°C–600°C	200°C–600°C
Limits of Aperture Size	0.0625"–0.0087"	0.500"–0.0087"	0.0500"–0.0014"
Aperture Plate Interchangeability from Optical Center Line	±.001"	±.003"	±.001"
Warm-up Time (to 600°C)	< 3 min.	< 20 min.	< 3 min.

ELECTRO-OPTICAL DIVISION
Perkin-Elmer *Corporation*
NORWALK, CONNECTICUT
CIRCLE 49 ON READER-SERVICE CARD



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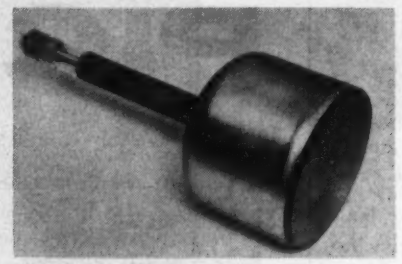
CIRCLE 50 ON READER-SERVICE CARD

FLYING SPOT SCANNER CRT

New Type 7BCP Series 7½" magnetic focus and deflection tube is designed for color and monochrome video signal generators, photo recording and other scanner and high resolution display applications. Gray



optical quality non-browning face plate permits 100:1 small area contrast range, does not limit high quality optical systems. Complete specifications are available.—*Allen B. Du Mont Laboratories, Inc.*, 750 *Bloomfield Ave., Clifton, N. J.*

CIRCLE 151 ON READER-SERVICE CARD

DIGITAL MULTIMETER

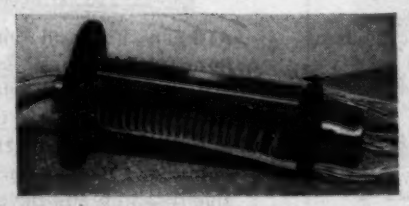
New Model 843 Digital Multimeter measures dc volts, dc ratios, ac volts and resistance. All solid-state circuitry provides exceptionally high reliability and accuracy with light

weight, compact size. Average reading time for dc voltage measurements is 50 milliseconds, 2 seconds for low frequency ac and ½ second for 400 cps and over. Ranging and polarity are automatic. Drift and stability characteristics are better than 0.005%.—*Electro Instruments, Inc.*, 3540 *Aero Court, San Diego*, 11, *Calif.*

CIRCLE 152 ON READER-SERVICE CARD

CENTRIFUGE SLIP RING

Assembly is designed to supply instrumentation and monitoring circuits, current for heaters to simulate aerodynamic heating and imped-

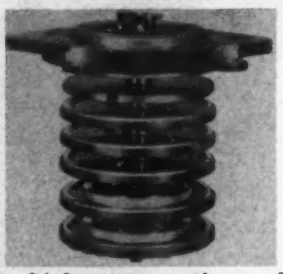


ance matched circuits for closed-loop video. 51 10-amp, 9 33-amp circuits; hi-pot test, 1000 v ac; S/N ratio, 100:1 or better.—*Slip Ring Co. of America*, 3612 *W. Jefferson Blvd., Los Angeles* 16, *Calif.*

CIRCLE 153 ON READER-SERVICE CARD

RADAR SLIP RINGS

New concentric slip ring assembly, providing switching from positive to negative for sine and cosine functions is typical of unlimited designs available. Arc resistant insulation

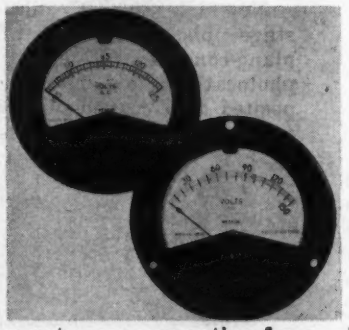


permits high power ratings, phasing is accurate to 0.20 minutes electrical and 0.005" mechanical, operate in −65° to 165° F ambients.—*Breeze Corporations, Inc.*, 700 *Liberty Ave., Union, N. J.*

CIRCLE 154 ON READER-SERVICE CARD

EXPANDED SCALE METERS

New Weston Expanded Scale ruggedized ac (and rectifier ac) types will be featured at WESCON booths 1042-43. Having an accuracy of ±0.5% of center scale value and



temperature compensation from −55° to 70°C, the new meters give true RMS readings.—*Weston Instruments Division, Daystrom, Inc.*, 614 *Frelinghuysen Ave., Newark* 12, *N. J.*

CIRCLE 155 ON READER-SERVICE CARD

NEON GLOW LAMPS

Four new high-current miniature neon glow lamps—SLT-2-32-1, RT2-32-1A, RLT2-27-1, and RLT2-27-1A—are designed for use as circuit components, switches, voltage regulators, and bright indicators. "R" numbers contain radioactive additive for reduced dark-starting effect. Voltage ranges from 55 to 80 v dc; current, 6.0 ma to 20.0 ma; life to 5,000 hrs.—*Signalite, Inc., Neptune, N. J.*

CIRCLE 156 ON READER-SERVICE CARD

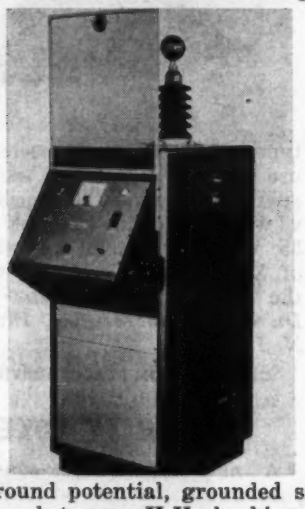
SOLID STATE COMPUTER

New Solid-State Commutator Series ES/35 samples data from multiple sources on a time sharing basis for application to a single input of recording equipment, indicating equipment, or data transmitting link such as a single telemetry sub-carrier channel. It makes possible observation simultaneously of all data sources during a flight or test run.—*Electronic Systems Development Corp.*, 1484 *E. Main St., Ventura, Calif.*

CIRCLE 157 ON READER-SERVICE CARD

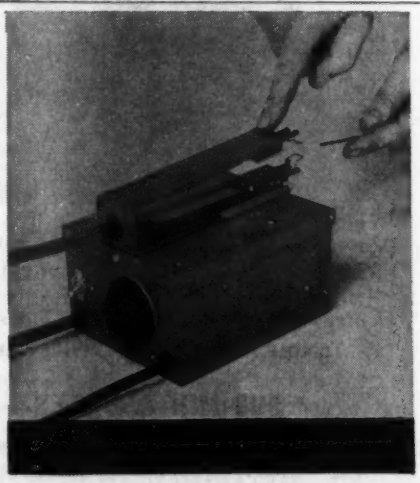
HIGH VOLTAGE TEST SETS

Test potentials to 150 KV are provided by a new line of high voltage test sets in deluxe console cabinets which include operator safety features such as cabinet and test panel



at ground potential, grounded safety screen between H-V bushing and operator, fast-acting circuit breaker, and many others. Complete description in Bulletin 4-10.25.—*Associated Research, Inc.*, 3777 *W. Belmont Ave., Chicago* 18, *Ill.*

CIRCLE 158 ON READER-SERVICE CARD



NEW MODEL G THERMAL WIRE STRIPPER

Strips both Teflon and low-melting plastics.
No blades to cut or nick wire.
Has continuously-variable heat control.
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Designed for production-line use.
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2420 North Lake Avenue, Altadena, Calif.

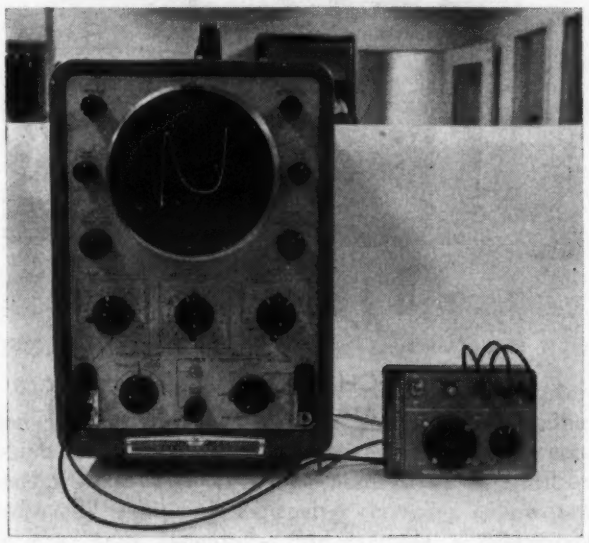
CIRCLE 51 ON READER-SERVICE CARD

Tunnel Diode Curve Tracer

Older electronics engineers will remember that early DeForest triodes were highly individualistic in their characteristic curves, and that the 1920 experimenter usually ran a few tests to determine optimum operating values for each tube. That tunnel diodes are now in a similar "state of the art" is evidenced by the development of a new design aid designated the TRAK Tunnel Diode Curve Tracer (See Figure).

This instrument, when used with a laboratory oscilloscope, presents the current-voltage characteristic of tunnel diodes throughout their negative resistance region. Both of the two types of tunnel diodes now being manufactured are accommodated.

A four-scale range switch adjusts the scale factor of the transformation from current voltage for the vertical deflection signal and simultaneously changes the shunt impedance on the tunnel diode. In anticipation of new diodes with different characteristics, the available range exceeds that required by currently available diodes. The knob of the range switch is a "Plug-In" type which doubles as a holder for the diode being tested. Separate knobs are supplied for each type of diode presently being manufactured, and future diodes will be accommodated by other knobs designed to their geometry.



The accuracy of conversion from current to voltage is ±1%; otherwise its accuracy depends upon the accuracy with which the deflection of the oscilloscope is calibrated. A second knob controls the oscilloscope sweep voltage from 0 to 1½ volts.

Stray inductances are so small that diodes capable of oscillating at 2 Kmc are adequately damped. The source impedance is approximately one ohm and the curve shown on the oscilloscope is continuous throughout the negative resistance region. The new Tunnel Diode Curve Tracer is a development of TRAK Electronics Co., Division of CBS Laboratories, Inc., 48 Danbury Rd., Wilton, Conn.

FOR MORE INFORMATION CIRCLE 159 ON READER-SERVICE CARD

MISSILE-TRACKING TRANSPONDERS

New subminiature transponders using solid state techniques except for magnetrons and local oscillator, provide tracking signals compatible with C-band tracking radars for tracking of missiles, drones and piloted aircraft. Type AN/DPN-63 (shown) weighs approximately 4 lbs and occupies less than 75 cu-in. for a range up to 500 miles. Type AN/DPN-63 (XCC) Solid State Transponder, for long range missiles, weighs 8.8 lbs and occupies a volume of only 200 cu-in. Primary power of 29 watts may be supplied from battery box if 25-30 v dc source is not available in missile or drone. Data sheets are available.—*Military Electronics Div., Motorola Inc., 8201 E. McDowell Rd., Phoenix, Ariz.*

CIRCLE 160 ON READER-SERVICE CARD

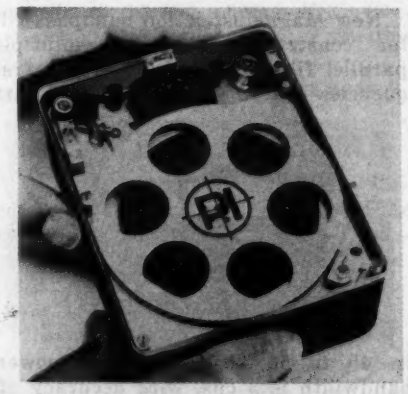
SHORT PULSE OSCILLATOR

New Type PG-650-C gives 300 v peak-to-peak pulses into a 93 ohm load from 0.5 to 50 μsec in duration, and at any frequency from 0.5 to 150 mc. —*Arenburg Ultrasonic Laboratory, Inc., 94 Green St., Jamaica Plain 30, Mass.*

CIRCLE 161 ON READER-SERVICE CARD

SUB-MIN TAPE SYSTEM

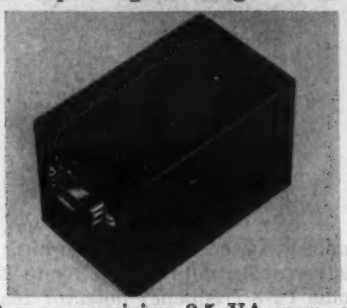
New Model PS300 Series instrumentation tape recorder weighs less than 2 lbs, including electronics; for multitrack data recording on ¼" to 1" tape using up to 60 ips bidirectional speeds with end-of-tape sensing. Modifications will be disigned to customer requirements for satellite and other special applications.—*Precision Instrument Co., 1011 Commercial St., San Carlos, Calif.*



CIRCLE 162 ON READER-SERVICE CARD

TELEMETRY DISCRIMINATOR

New Model 91-105-0 frequency discriminator for telemetery, recording or instrumentation has factory adjusted range of 360 to 440 cps with a sensitivity of 62.5 mv/cycle deviation. Input signal range is 95 to 150 v ac requiring 2.5 VA max, output is 0 v dc at 360 cps to 5 v dc at 440 cps. Weighing only 1 lb., the unit meets applicable portions of MIL-E-5272A.—*Magnetic Research Corporation, 3160 West El Segundo Blvd., Hawthorne, Calif.*



CIRCLE 163 ON READER-SERVICE CARD

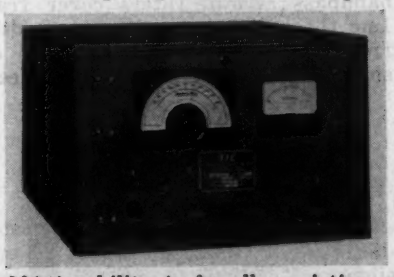
FM & AM MONITOR

ECI Model 36 Monitor Receiver, operating from 225 to 399.9 mc, receives FM voice, FSK, FM-FM telemetry, and digital data transmissions in the FM mode; or UHF aircraft traffic control, AM voice and AM-FM telemetry transmissions in the AM mode. Operates from 115 v 60 cps line, mounts in rack or with dust cover on bench.—*Electronic Communications, Inc., 1501 72nd St. N., St. Petersburg, Fla.*

CIRCLE 164 ON READER-SERVICE CARD

FREQUENCY CONVERTER

New Model 4025A delivers 250 VA output at a wide selection of frequency ranges from 50 to 4000 cps with fixed frequency accuracies up to 0.001%, ability to handle resistive or reactive loads, nominal 1% harmonic distortion, zero output impedance and zero recovery time; for missile checkout, servo system testing, aircraft instrument testing, etc.—*Dept. X, Tel-Instrument Electronics Corp., 728 Garden St., Carlstadt, N. J.*



CIRCLE 165 ON READER-SERVICE CARD

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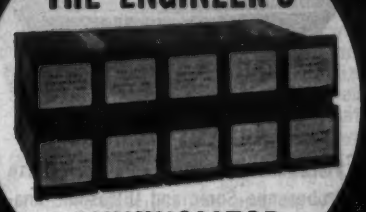
DE-LINE

THE ENGINEER'S



ANNUNCIATOR

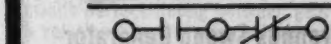
GREATEST FLEXIBILITY IN THE FIELD

AVAILABLE IN MANY SEQUENCES

BACKLIGHTED OR BULL'S-EYE

SIDE BY SIDE OR STACKED, DE-LINE modular design retains original custom appearance as system grows.

SAME PLUG-IN operates from normally open OR normally closed trouble contacts.



AUXILIARY CONTACTS N.O.-N.C. standard with most plug-ins.

SEQUENCE OPTION after installation by means of independent slide switch at each point.

DE-LINE plug-ins are self-policing. Systems are rugged and dependable.

THE SCAM INSTRUMENT CORP.

Dept. H, 1811 W. Irving Park Rd. • Chicago 13, Ill.
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REPRESENTATIVES IN ALL PRINCIPAL CITIES

COMPLETE MONITORING SYSTEMS FOR INDUSTRY

CIRCLE 52 ON READER-SERVICE CARD

HIGH RESOLUTION SPECTRUM ANALYZERS

Analysis Problems

Vibration • Distortion • Pulses • Noise

Probescope Sonic and Ultrasonic analyzers all have automatic optimum resolution circuitry. Guesswork has been taken out of spectrum analysis. One control sets the proper bandwidth and sweepwidth to give the best possible resolution... other features include... 60 db dynamic range... linear and log amplitude scales... internal calibration markers.

SPECIFICATIONS	SS-20
Frequency Range	7 cps to 23 kc
Sweep Width	50 cps to 6 kc
Sensitivity	500 microvolts
Resolution	14 cps

SPECIFICATIONS	SS-100
Frequency Range	13.5 cps to 110 kc
Sweep Width	200 cps to 20 kc
Sensitivity	500 microvolts
Resolution	27 cps

SPECIFICATIONS	SS-500
Frequency Range	75 cps to 600 kc
Sweep Width	2 kc to 200 kc
Sensitivity	250 microvolts
Resolution	150 cps

Synchronous Sweep Generator

All Probescope analyzers feature 100 db dynamic range sweep generator attachments to visually display passband characteristics of amplifiers and filters. Noise and distortion which normally obscures response curves are eliminated.

Other spectrum analyzer models for subsonic, single sideband and telemetering analysis.

Write for more information.

PROBESCOPE COMPANY INC.
8 SAGAMORE HILL DR., MANORHAVEN, L.I., N.Y.
POrt Washington 7-8150

CIRCLE 53 ON READER-SERVICE CARD

LIMIT DETECTORS

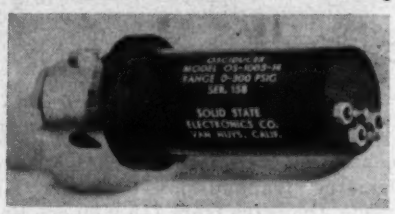
A new 4-model line of voltage and frequency detectors includes: Model PT-2, ac detector with high and low settable limits from 105 v to 125 v;

Model PT-4, dc detector with high and low settable limits from 22 v to 32 v; Model PI-3 frequency detector featuring high and low settable limits from 48 to 72 cps and Model PI-14 frequency detector offering high and low settable limits from 320 to 480 cps.—*Anadex Instruments Inc.*, 14734 *Arminta St., Van Nuys, Calif.*

CIRCLE 166 ON READER-SERVICE CARD

TRANSDUCER/OSCILLATOR UNIT

New Osciducer, ultra-miniature pressure-to-frequency converter for FM-FM telemetry requires only three connections; 28v dc at 2 ma, ground, and lo-Z output from the silicon transistor emitter follower. Sup-



plied for all IRIG channels, deviation is nominally ± 7.5% of center frequency. Pressure transducers from 5 to 5000 psi are available.—*Solid State Electronics Co.*, 15321 *Rayen St., Sepulveda, Calif.*

CIRCLE 167 ON READER-SERVICE CARD

HF CRYSTAL FILTER

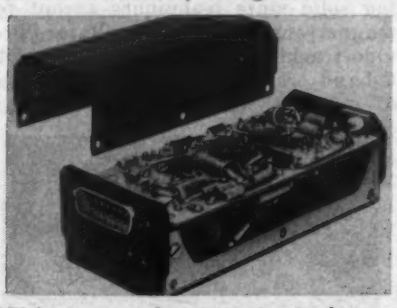
New KCF Series high frequency bandpass crystal filters cover from 1mc through 21 mc with bandwidths from 0.01% to 0.45% with 60/6 db shape factors from 4/1 to 2/1. Meets

all applicable MIL-specs for doppler radar, receiver IF, comb filters or wherever high stability and narrow bandwidths are required.—*The Keystone Electronics Co.*, 65 *Seventh Ave., Newark* 4, *N. J.*

CIRCLE 168 ON READER-SERVICE CARD

SUBCARRIER OSCILLATOR

New transistorized strain-gage subcarrier oscillator, designated Model

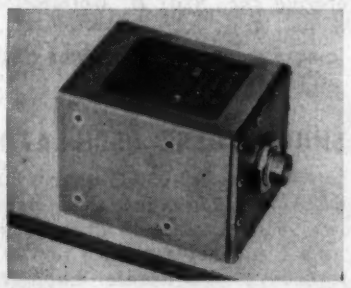


179A, accurately converts strain-gage bridge signals into FM subcarrier signals on IRIG channels 1 to 14 and A in missile or aircraft environments.—*Electro-Mechanical Research, Inc., Sarasota, Fla.*

CIRCLE 169 ON READER-SERVICE CARD

LOW FREQUENCY STANDARD

Crystal controlled outputs of 400 cps, 3200 cps and 25.6 kc accurate to ±0.005% are furnished by new Model R-2 frequency standard for

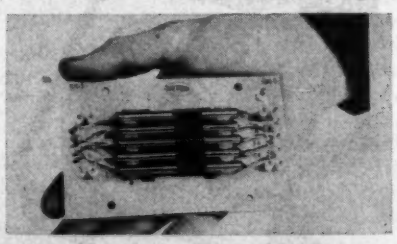


use as bias, timing and capstan reference signals for airborne tape recorders. Dimensions are 3" x 3" x 4", weight is 24 oz and the unit meets MIL-E-5411 and MIL-E-5272A.—*Kennedy Co.*, 2029 *N. Lake Ave., Altadena, Calif.*

CIRCLE 170 ON READER-SERVICE CARD

MAGNETOSTRICTION FILTER

New Magnetostriction bandpass filter construction provides multiple parallel filter arrays with center frequencies spaced one bandwidth apart

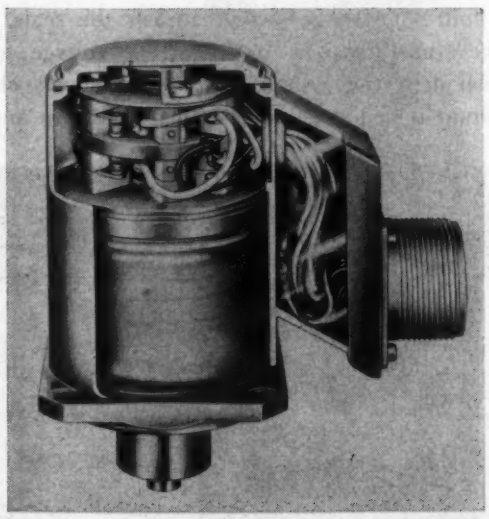


in 45 to 50 kc range. Half-power bandwidth is 3 cps, with accuracy of center frequency adjustment within 0.3 cps. Uses include vibration test equipment, spectrum analyzers, sonar, telemetry in abd wireless paging systems. Ten-filter bank weighs only 12 oz.—*Industrial Components Div., Raytheon Co.*, 55 *Chapel St., Newton, Mass.*

CIRCLE 171 ON READER-SERVICE CARD

Missile Launcher Interlock is Fail-Safe

A new electromechanical interlock, designed for airborne Missile-launcher applications, but also applicable in other high-reliability systems, has been developed by Electroid Corp., of Union, N. J. Designated the AM-1500 Solenoid Relay, it comprises a two coil pull type solenoid which actuates a 0.375" diameter retaining pin. The husky retaining pin is engineered to withstand 3000 lbs static side force.



ELECTROMECHANICAL Missile Launcher Interlock contains five independent switches.

Interlocking depends on five independent internal SPDT switches of novel design, directly actuated by the retaining pin. Because these switches can be set to within ±0.01" of any predetermined operating point—with two made to operate at the beginning of the stroke while the remaining operate at the end of the stroke—the switches can be made to interlock remote mechanical or electrical actions, thus providing a fail-safe feature on aircraft, missiles and missile launchers. For example, switches may be electrically interlocked either internally or externally with the firing squib, landing gear, etc., to positively prevent firing the missile before it is unlatched and to provide positive retention of the missile during landing or violent maneuvers.

The solenoid operates with a net force of 15 lbs at 12 v dc over a 0.25" stroke, simultaneously overcoming and compressing a return spring of 10 lbs force. Rated actuating current is 19 amperes at 29 v dc while the holding current is only 1 amp at 29 v dc.

High shock and vibration resistance of the C-1500 unit and rugged construction enables the unit to meet MIL-S-7029, MIL-E-5272 and MIL-S-4040 specifications.

FOR MORE INFORMATION CIRCLE 172 ON READER-SERVICE CARD

ATLAS to use Ball and Socket Multiple Connector

A new Two-ball and Socket principle (Fig. 1) which permits the ball end of each contact pin to mate with a split sleeve that is loosely retained with one of the balls, is employed in a new modular connector designed and supplied by the Cole Electric Co., 8439 Steller Drive, Culver City, Calif., for Convair Astronautics, prime contractor for the ATLAS ICBM.

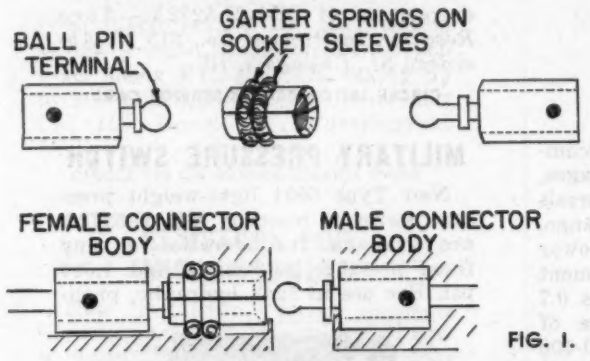


FIG. 1.

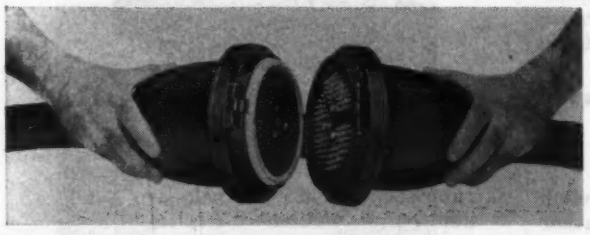


FIG. 2. COLE multiple connector.

The Cole connector permits extremely low insertion and extraction pressures and is self-aligning, which permits a simple and lightweight hinge-type connector shell (Fig. 2) to be used in an application ordinarily requiring expensive screw-on, screw-jack or lever type fastenings. For example, a 48-contact Cole Connector using #16 pins requires an insertion force of only 18 lbs and an extraction force of 15 lbs as compared with conventional type connectors requiring 100 lbs. insertion and 125 lbs extraction forces.

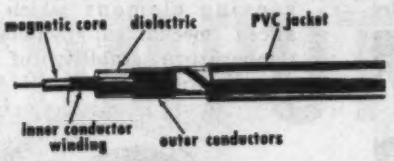
Contact pins for Cole Connectors are available in 15, 30, 75, 150 and 300 ampere capacities. Any combination of pin sizes can be used in a single connector, allowing for complete versatility. Because of its self-aligning principle and low resistance values, a Cole Connector can be designed using a transfer plate with moving sleeves or pins connected in series with the basic plug or receptacle. This disconects the circuits either in the receptacle or plug, giving dead-front protection at the base connection of the wires located deep in either unit, permitting all connections to be made in an explosion-safe area.

Modular construction provides three interchangeable pin and receptacle inserts in each connector, making possible limitless contact configurations with a small number of types of parts. This simplifies the logistics of manufacturing, stores and field equipment repairs. Also large or small prototype designs can be quickly and inexpensively provided, made from a large variety of materials to meet special environmental conditions.

FOR MORE INFORMATION CIRCLE 173 ON READER-SERVICE CARD

TIME DELAY CABLE

New Type HH-1500A (RG-266/U) magnetic core delay cable with impedance of 1500 ohms and a delay of

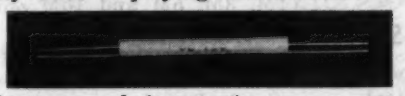


0.08 μsec/ft is said to have a delay-to-rise time ratio of 100:1. O.D. is 0.400" and cable is available in 100 ft bulk lengths or in calibrated sections with molded PVC end caps and tinned leads.—*Columbia Technical Corp.*, 61-02 *Thirty-First Ave., Woodside* 77, *N. Y.*

CIRCLE 174 ON READER-SERVICE CARD

LC DELAY LINES

New submin lumped constant delay lines employing subminiature in-



ductors and temperature compensating capacitors, feature high stability in characteristics temperatures from −55°C to 105°C. Typical Type DL-130 illustrated has a delay time of 2 μsec a rise time of 0.22 μsec, an impedance of 1,000 ohms and an insertion loss of 0.001 db max. Its size is 3" long x 0.5" dia.—*Allen Avionics Inc.*, 225 *E. 2nd St., Mineola, L. I., N. Y.*

CIRCLE 175 ON READER-SERVICE CARD

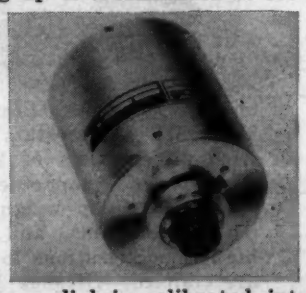
TRIPLE OUTPUT DELAY

New delay line with particular applications in variable coding systems provides three variable taps over a total delay of 1.5 μsec. Taps can be individually adjusted over the delay range with a resolution of 0.025 μsec, pulse rise time of 0.07 μsec, and attenuation of 2 db (max). Impedance is 300 ohms.—*ESC Corporation*, 534 *Bergen Blvd., Palisades Park, N. J.*

CIRCLE 176 ON READER-SERVICE CARD

VARIABLE DELAY TRIGGER

Variable magnetostrictive delay line used to delay trigger pulse in radar systems is designated VM-1030, providing up to a maximum of 500 μsec.

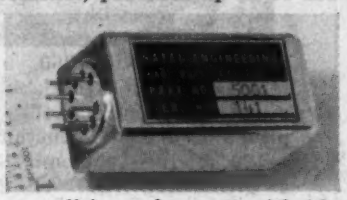


Ten-turn dial is calibrated into 100 divisions/turn, can be set to accuracy of ±0.5 μsec. Optimum pulse input is 1 μsec, insertion loss at the end of the range is 56 db and the maximum pulse rate is 300 kc.—*Control Electronics Co., Inc.*, 10 *Stepar Place, Huntington Station, L. I., N. Y.*

CIRCLE 177 ON READER-SERVICE CARD

MINI DELAY RELAY

New low-cost time delay relay exceeding MIL-R-5757C Class B requirements, provides up to 60 sec de-



lay on pull-in or drop-out with 20 milliseconds reset and instantaneous recycling. Test-qual report on request. —*Natel Engineering Co., Inc.*, 15922 *Strathern St., Van Nuys, Calif.*

CIRCLE 178 ON READER-SERVICE CARD

SOLID STATE TIMERS

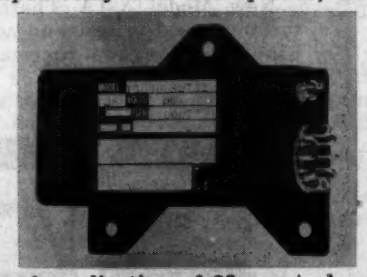
New WC-600 series Electronic Repeat Cycle and Time Delay Timers, while designed for missiles, aircraft

and ground support applications, has other electronic industry uses. Repeat Cycle Timer shown operates from 24-30 v dc, cuts off power 60 sec after cycle is triggered. Power is gated on again at end of a second 60-sec "off" period. See at WESCON Booth 2421. —*Webcor, Inc.*, 816 *No. Kedzie Ave., Chicago* 51, *Ill.*

CIRCLE 179 ON READER-SERVICE CARD

DELAY RELAY

Precise time delay-on-drop-out ("DODO") is provided by new Solid State Timing Module teamed with output relay. When 28 v power is applied, output relay does not operate; addi-



tional application of 28v control voltage operates output relay immediately, latching to power line while timing circuit is held in "off" state. Upon removal of control voltage, timing circuit is activated and on completion of timing cycle, fires, de-energizing output relay and unlatching circuit from power supply.—*Tempo Inst. Inc.*, *P. O. Box* 338, *Hicksville, N. Y.*

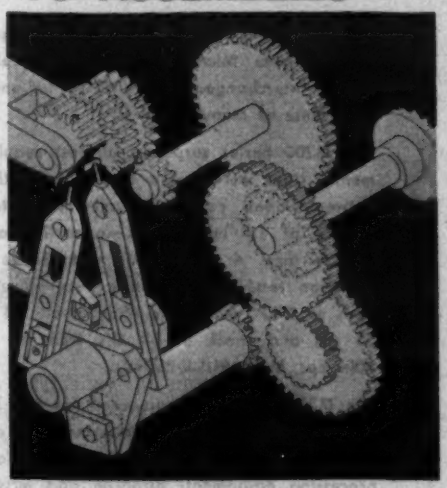
CIRCLE 180 ON READER-SERVICE CARD

FROM BLANKS

TO GEARS

H. O. Boehme, Inc. is unsurpassed as a facility for the production of quality precision products. Over 3 decades of experience on specialized precision work in the fields of Instrumentation and Automation has provided us with the rare discipline required to produce custom-made fine pitch precision gears to A.G.M.A. Precision #3 specifications and the closest of tolerances. Our engineering staff is progressive, our craftsmen are highly skilled and experienced, our facilities include the latest, accurate fabrication and testing equipment.

TO ASSEMBLIES



The Boehme gear assembly shown here demands perfect timing between gear elements, a relationship that can only be obtained by gears of perfect true form.

Modern industrial techniques and a rigorous quality control system enables us to offer you high precision products to meet your exacting specifications and tolerances, and at the same time to keep production costs within budgetary limitations. Whatever your need—design, engineering, precision products, custom-made gears and assemblies—in small quantity or in production runs—your inquiries are invited. There is no obligation, of course.

H. O. Boehme, Inc.

Contractors, Designers, Manufacturers of Precision Electrical, Electro-Mechanical and Electronic Equipment since 1917

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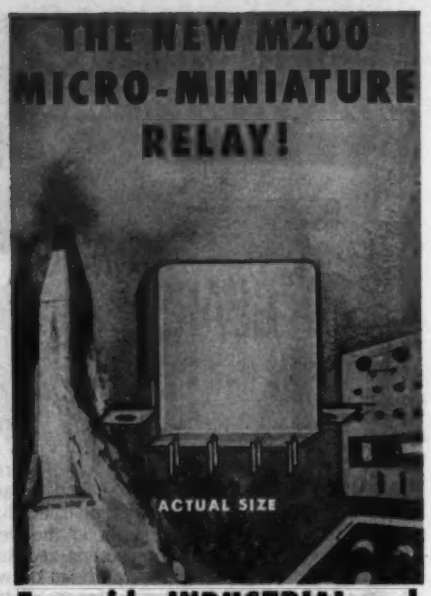
New York 10, N.Y.

HOB

CIRCLE 54 ON READER-SERVICE CARD



For wide INDUSTRIAL and MILITARY APPLICATIONS!

Features:

- √ .200 Grid, Crystal Can
- √ Non-latching DC, 2PDT
- √ 2 Ampere Contacts
- √ Hermetically Sealed
- √ General Purpose, Dual Coil

Here is the NEW U.S. Relay-Electronics general purpose Micro-Miniature M200 Relay Series—interchangeable with all similar units, regardless of manufacturer!

The M200 Series surpasses all test requirements! Units were tested at 750 volts RMS between open contacts—Maximum contact bounce of 1.5 milliseconds—operating and release time, 4 milliseconds and Grade 4 vibration tests in 3 mutually perpendicular axes at .200" double amplitude from 10 to 55 cps and shock of 30 G's from 55 to 3000 cps. Meets MIL-R-25018.

The M200 Series is engineered for use in: computers; special small sub-systems for applications with aircraft and missiles; data processing equipment; airborne and missile check-out equipment; automation equipment; and communications equipment. M200 versatility is unmatched for any application—INDUSTRIAL or MILITARY!

For further information and certified test reports on the M200 Series, write to:

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Leading the art with quality Relays.

U. S. RELAY-ELECTRONICS

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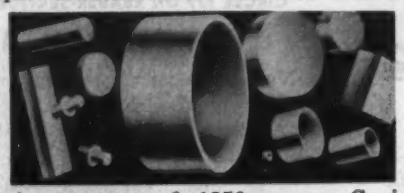
717 North Coney Avenue, Azusa, California

CIRCLE 55 ON READER-SERVICE CARD

SONIC TRANSDUCER

New ceramic transducer element, designated US600, has a resonant frequency which is constant up to 200 cps. Characteristics include: Dielec-

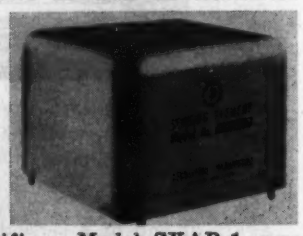


tric constant of 1350, upper Curie temperature of 310°C, a radial coupling coefficient of 0.46, a linear coupling of 0.67, d-constant (d_{31}) of -120×10^{-12} coulomb/newton, and a g-constant (g_{33}) of 25.3×10^{-3} $\frac{\text{Volt/meter}}{\text{newton/meter}^2}$.—*U.S. Sonics Corp.*, 625 *McGrath Highway, Somerville, Mass.*

CIRCLE 181 ON READER-SERVICE CARD

TRANSDUCER CONVERTERS

New line of Sensing Element modules translates from common physical variables to dc signal compatible with usual dc reference voltages and with output impedance low enough to drive as well as transistor pre-

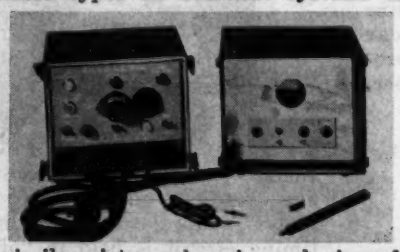


amplifiers. Model SXAR-1, rms-to-dc converter (illustrated) accepts 0-1/10/40/160/320 v rms to give lv dc output full scale; accuracy ±5%. Also for current sensing, with current shunt or transformer.—*Regulators, Inc.*, 455 *W. Main St., Wyckoff, N. J.*

CIRCLE 182 ON READER-SERVICE CARD

THERMAL SWITCH TESTER

New Model X-1A Thermal switch tester is used to test and adjust overheat detectors and thermal switches of the normally-open or normally-closed types on overheat systems of

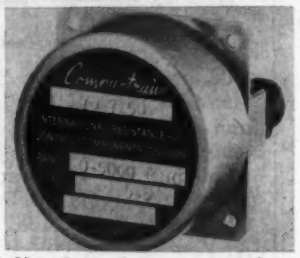


missiles, jets and reciprocal aircraft in accordance with MIL-T-7465A. Accuracies of ± 5°F over its 0-1000°F range are attained. Null balance circuit and digital readout dial permit instant errorless reading.—*Projects Unlimited*, 1926 *East Siebenthaler Ave., Dayton* 14, *Ohio.*

CIRCLE 183 ON READER-SERVICE CARD

PRESSURE TRANSDUCERS

Seven new lightweight Type 'R' pressure transducers, featuring a precision Ni-Span-C Bourdon tube sensing element which, with balanced mechanical system, provides temperature stability of 0.01%/F° over the range from —65°F to 350°F.



Multiplication of movement is accomplished without pivots or linkages, affording 1% linearity and hysteresis as low as 0.5% for the 100 psi range. Meet MIL-E-005272-B. The power rating of the potentiometer element (1M, 3M, 5M and 10M ohms) is 0.7 watts at 70°F; pressure range of the seven models varies from 0-100 PSIG to 0-5,000 PSIG.—*Control Components Div. International Resistance Co.*, 401 *N. Broad St., Philadelphia* 8, *Pa.*

CIRCLE 184 ON READER-SERVICE CARD

THERMAL SWITCH

New precision "Tip-Stat" switch responds to tip temperature rather than shell temperature. Provides fas-

ter response to rising temperatures in generator windings or bearings to be protected. Reaction time is less than 0.5 sec and temperature differential is 1° to 2° F. Meets MIL-S-25345 Amendment 2.—*Control Products, Inc.*, 306 *Sussex St., Harrison, N. J.*

CIRCLE 185 ON READER-SERVICE CARD

DISC THERMOSTATS

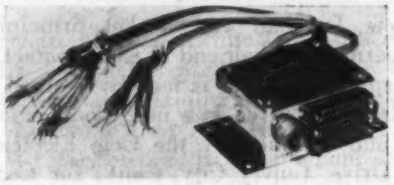
New Type MX bimetal disc thermostats for use in missile, avionic and astrionic applications can now be supplied with differential of 1° to 4°F

on special order. Standard Stemco Type MX thermostats are available with differentials of 2° to 6°F. In addition to compactness and small cubage, a light weight of approximately 5 grams, and resistance to high G accelerations to MIL-E-5272C are claimed.—*Stevens Manufacturing Co., Inc., P.O. Box* 1007, *Mansfield, Ohio.*

CIRCLE 186 ON READER-SERVICE CARD

THERMOCOUPLE REFERENCE

New heated reference junction for airborne use is miniature unit which



replaces conventional ice bath as reference for thermocouples. Meets requirements of MIL-E-5272A.—*Aero Research Instrument Co.*, 315 *N. Aberdeen St., Chicago* 7, *Ill.*

CIRCLE 187 ON READER-SERVICE CARD

MILITARY PRESSURE SWITCH

New Type 6621 light-weight pressure switches meeting MIL-E-5272A are available for operation at any fixed pressure between 5 and 1,000 psi. For use in fuel, hydraulic, pneu-

matic or refrigeration systems in temperatures from —65°° to 275°F, a wide variety of switch-contact arrangements and terminals are available.—*Consolidated Controls Corp., Bethel, Conn.*

CIRCLE 188 ON READER-SERVICE CARD

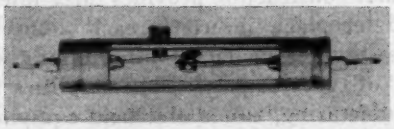
PRESSURE CALIBRATOR

Calibration of air speed indicators, machmeters, air data computers and altimeters can be readily accomplished by new PSC-2 Pressure Controller which generates and maintains extremely accurate (to 0.0005" Hg or less) pressures from —1000′ to +100,000′ static altitude, or impact pressures from 0 to over 1000 knots. Consists on adjustable, sensitive pressure regulator; a micro adjustment; and a servo system that precisely adjusts the regulator, compensating for any subsequent drift.—*Hass Instrument Corp.*, 6173 *Branch Ave., Washington* 23, *D.C.*

CIRCLE 189 ON READER-SERVICE CARD

MINI THERMOSTAT

New BW ¼" dia insulated thermostat can be factory calibrated or externally adjusted to obtain the de-

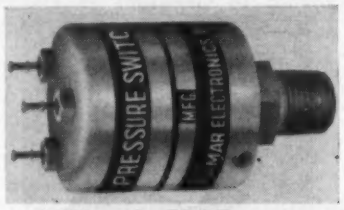


sired actuating temperature, unaffected by ambient temperature.—*Chatham Controls Corp.*, 141 *River Rd., Chatham, N. J.*

CIRCLE 190 ON READER-SERVICE CARD

MINI PRESSURE SWITCH

New pressure switch PS375-1, weighing less than ½ oz, can be adjusted to within ±0.5% of the original setting within the operating range

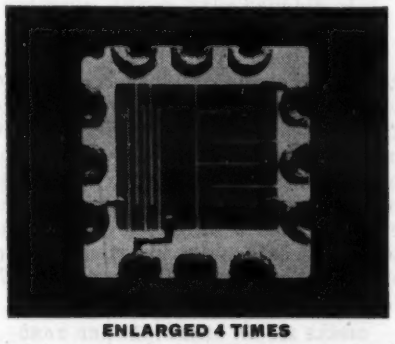


from 0-500 psi. SPDT snap action switch is rated for 6 amp at 125/250 v ac. Meets MIL-E-5272A, taking up to 100 G shock.—*Pamar Electronics Co., 103 Marine St., Farmingdale, N. Y.*

CIRCLE 191 ON READER-SERVICE CARD

RESISTORS FOR MICROMODULES

New metal-film wafer elements used in micromodules are 0.3" x 0.3" x 0.010" thick. As many as four



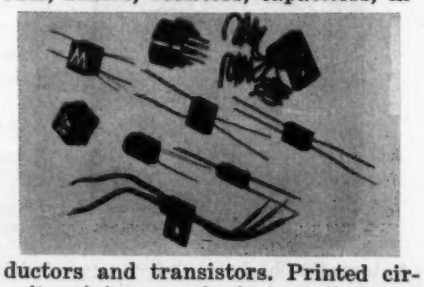
ENLARGED 4 TIMES

resistors can be provided on a single wafer, giving a packaging density as high as 600,000 parts per cu-ft. Engineering Bulletin 1007 describes details. Customer specifications welcomed.—*Ohmite Manufacturing Co., 3669 Howard St., Skokie, Ill.*

CIRCLE 192 ON READER-SERVICE CARD

SUBMIN ASSEMBLY PACKAGES

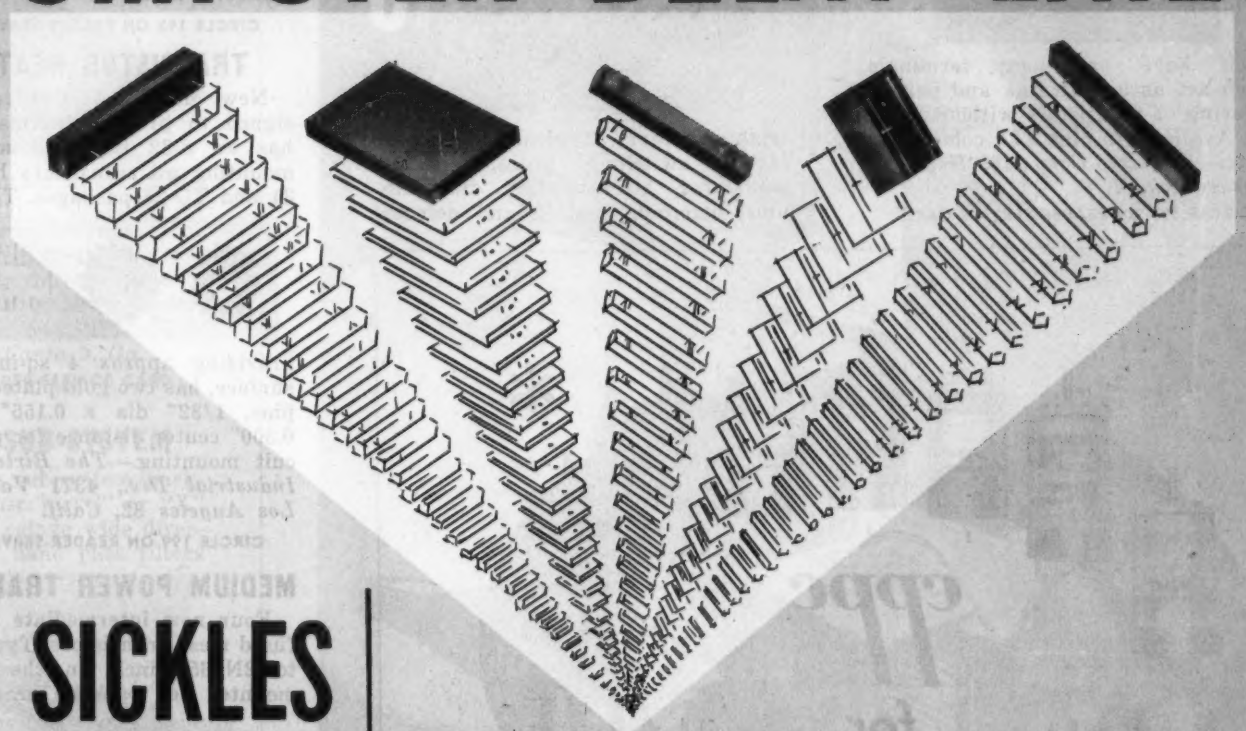
Six new "Weepak" packages are available "off-the-shelf" for encapsulation various combinations of diodes, zeners, resistors, capacitors, in-



ductors and transistors. Printed circuit, miniature tube base and clamp-on mountings are available in metal or epoxy cases. Matching service for diodes and transistors, also environmental and qualification testing service, is available.—*Wells Electronics Co., 1701 S. Main, South Bend 23, Ind.*

CIRCLE 193 ON READER-SERVICE CARD

currently mass producing
COMPUTER DELAY LINES



SICKLES
WORLD'S LARGEST MASS PRODUCER OF DELAY LINES
2 or 20,000 units per week!

custom-made
at mass production prices

When Sickles undertakes a delay line problem the customer's electrical and mechanical requirements are attained as a matter of course . . . and in many instances we surpass them. Recently our engineers accomplished the following for our customers:

- Reduced the size 2½ times – permitting major improvements in an overall computer circuit.
- Made a delay line fire resistant and impervious to special processes inherent in computer manufacture.
- Developed special packaging that solved other problems in computer assembly.
- Maintained a mechanical accuracy permitting the delay lines to be inserted into a printed circuit board without additional adjustment of the leads.
- AND delivered these delay lines *at a particularly low unit cost!*

More than likely, Sickles can achieve the same or similar success with your delay line problem. For information, write to Section M-8 at our office nearest you.

DIAMOND WEAVE SICKLES QUALITY APPARATUS

F. W. SICKLES
Division of GENERAL INSTRUMENT CORPORATION
LEADERS IN ELECTRONIC COIL WINDING AND ASSEMBLY SINCE 1921
165 Front Street (P.O. Box 330), Chicopee, Massachusetts
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GENERAL INSTRUMENT CORPORATION INCLUDES F. W. SICKLES DIVISION, AUTOMATIC MANUFACTURING DIVISION, SEMICONDUCTOR DIVISION, RADIO RECEPTOR COMPANY, INC., THE HARRIS TRANSDUCER CORPORATION, MICAMOLD ELECTRONICS MANUFACTURING CORPORATION AND GENERAL INSTRUMENT — F. W. SICKLES OF CANADA LTD. (SUBSIDIARIES)

CIRCLE 56 ON READER-SERVICE CARD

4-PIN TRANSISTOR HOLDER

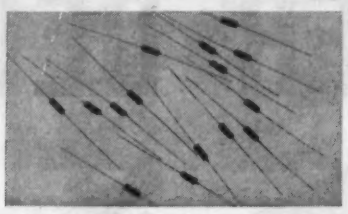
New Type TC-400T four-pin transistor holders supplement TV-300T (3-pin) transistor holders, both of

which have extra-long terminals which act as a heat sink and permit soldering of transistors without damage. Available in nine EIA colors plus white.—*Sealectro Corp.*, 139 *Hoyt St.*, *Mamaroneck, N. Y.*

CIRCLE 197 ON READER-SERVICE CARD

SILICON DIODES

New line of reliable diffused silicon diodes, comprising fast recovery types and high conductance types, are designed for airborne and indus-



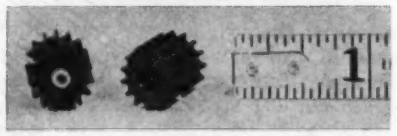
trial computers. Typical applications include switching, pulse, flip-flop, modulator, demodulator, discriminator, clamping, gating and detector circuits.

Fast recovery types 1N625 through 1N629 provide 400,000 ohms (Zrec) in 1.0 μsec (I_F=30 ma, E_R=35V, R_L=2K ohms). High conductance types 1N482 through 1N485 feature a max average forward current of 100 ma at 1.1 volts.—*CBS Electronics Information Services*, 100 *Endicott St.*, *Danvers, Mass.*

CIRCLE 198 ON READER-SERVICE CARD

TRANSISTOR HEAT SINK

New Model 3AL-685 radiator designed to prevent thermal runaway has an 8-32 tapped stud hole for mounting all transistors having TO-31 and TO-26 packages. The radiator

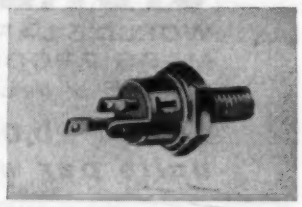


providing approx 4 sq-in radiating surface, has two gold-plated mounting pins, 1/32" dia x 0.155" long and 0.300" center distance for printed circuit mounting.—*The Birtcher Corp.*, *Industrial Div.*, 4371 *Valley Blvd.*, *Los Angeles* 32, *Calif.*

CIRCLE 199 ON READER-SERVICE CARD

MEDIUM POWER TRANSISTORS

Four new intermediate power diffused mesa transistors, Types 2N1647 to 2N1650 incl., in the $\frac{7}{16}$" stud-mounted hex package provide power

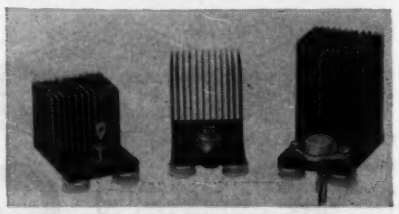


dissipation of 20w at 100°C case; low saturation resistance (typical 1.7 ohms); good beta linearity with operating current range of 50 ma to 2 amp; and voltage of up to 120.—*Transitron Electronic Corp.*, 168 *Albion St.*, *Wakefield, Mass.*

CIRCLE 200 ON READER-SERVICE CARD

SEMICONDUCTOR RADIATORS

New Heat Sinks in R-5000 Series for transistors in the 5 to 100 watt dissipation range enable transistor rated by the manufacturer at 10 watts



to be operated at 30 watts under forced convection. Applications to rectifier, zener diode and transistor are illustrated.—*Wakefield Engineering, Inc.*, 11 *Broadway*, *Wakefield, Mass.*

CIRCLE 201 ON READER-SERVICE CARD

TRANSISTOR THERMAL TESTER

New Test Set gives rapid and foolproof temperature measurements needed in electronic equipment design. All temperatures are direct

reading on the meter scale with automatic ambient temperature compensation, from any of four thermocouple inputs.—*Rescon Electronics Corp.*, *Dept.* 5, 151 *Bear Hill Rd.*, *Waltham* 54, *Mass.*

CIRCLE 202 ON READER-SERVICE CARD

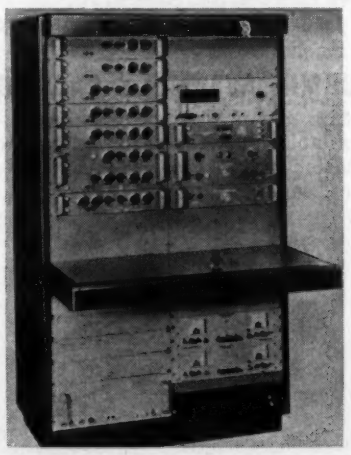
TRANSISTOR CHECKER

New Model 1003 checks all important transistor dc parameters, including those in the inverted connection. A remote connector also permits checking while a transistor is in an environmental chamber provides Beta measurements for any value of base current from 0 to 100 micro-amperes by use of externally inserted base resistors.—*Dynatron Laboratories*, 71 *Glenn Dr.*, *Camarillo, Calif.*

CIRCLE 203 ON READER-SERVICE CARD

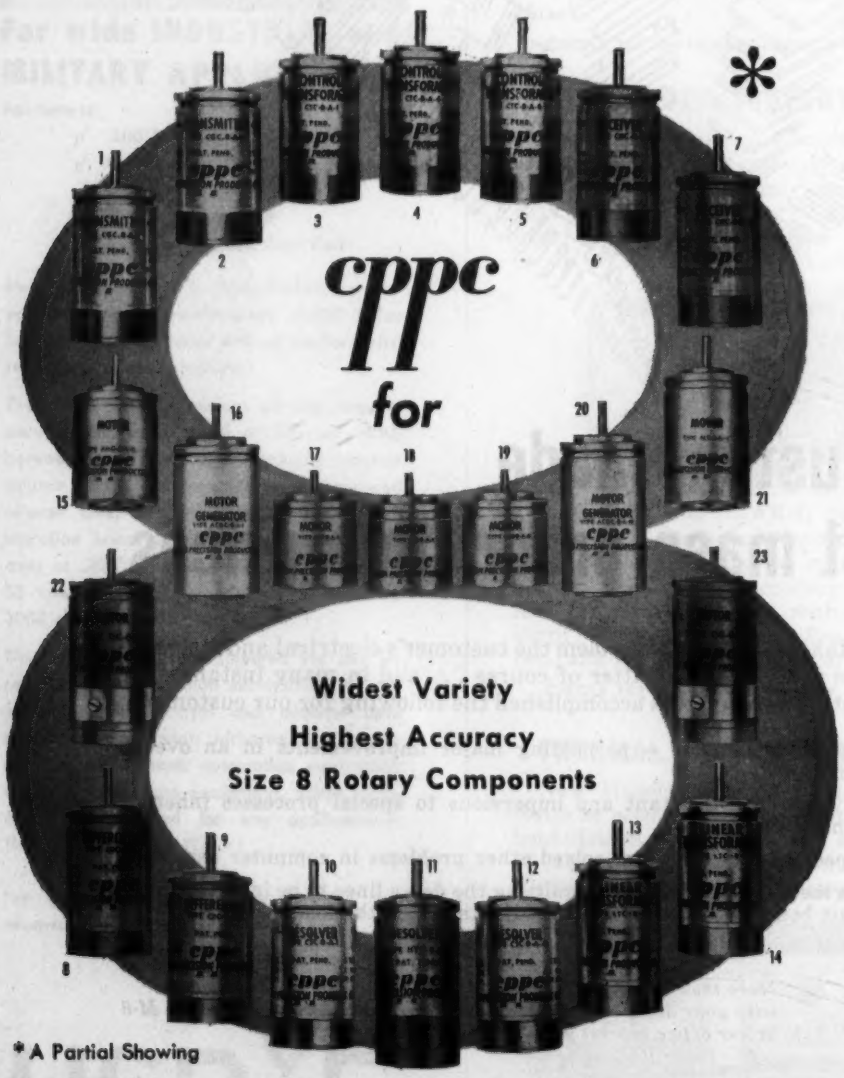
SEMICONDUCTOR TEST

New Automatic Semiconductor Test Station was developed to meet the need for increased quality in production and incoming inspection testing.



Automatic high speed testing with evaluation of transistor or diode performance accomplished by means of a precision GO, NO-GO comparator eliminates human decision. 700 semiconductors/hr may be tested with 100% reliability. See at WESCON.—*Optimized Devices, Inc.*, 864 *Franklin Ave.*, *Thornwood, N. Y.*

CIRCLE 204 ON READER-SERVICE CARD



* A Partial Showing

Clifton Precision's size 8 rotary components have been tried and proven by customers over the past 4 years. More than 50,000 have been shipped. These are the most accurate and best tested (because they are use tested) size 8 rotary components on the market today.

1. Torque transmitter (26v. input) 2. Torque transmitter (115v. input) 3. Control transformer (lo Z) 4. Control transformer (hi Z) 5. Control transformer (very hi Z) 6. Torque receiver (26v. input) 7. Torque receiver (115v. input) 8. Torque differential (lo Z) 9. Torque differential (hi Z) 10. Electrical resolver (.5 t.r.) 11. Precision computing resolver (feedback winding) 12. Electrical resolver (1 t.r.) 13. Linear transformer (115v. input) 14. Linear transformer (26v. input) 15. Servo motor (1" length, .40 in-oz stall torque) 16. Motor generator (10v. input) 17. Servo motor (53/64" long) 18. Servo motor (35v. center tap) 19. Servo motor (26v. center tap) 20. Motor generator (26v. input) 21. Servo motor (.30-in-oz stall torque) 22. D.C. motor (14v. input) 23. D.C. motor (28v. input)

CLIFTON PRECISION PRODUCTS CO., INC.
CLIFTON HEIGHTS, PA.
Sales Office: 5050 State Rd., Drexel Hill, Pa. MAdison 2-1000, TWX Flanders, Pa. 1122

cppc

CIRCLE 57 ON READER-SERVICE CARD

SOCKET FOR RCA MICROMODULE

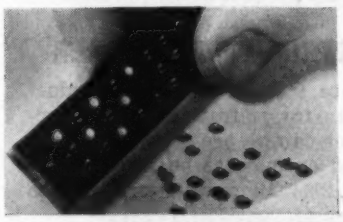
New JETTRON socket fabricated of DIALL FS-5 with beryllium copper contacts is designed to mount

on a printed circuit board and is only 0.094" high. Square dimension of socket is .400" max, with corner guide brackets of 18-8 stainless, allowing mounting of micromodules on .400" Centers.—*Jettron Products, Inc.*, 56 *Route* 10, *Hanover, N. J.*

CIRCLE 205 ON READER-SERVICE CARD

S-BAND TUNNEL DIODES

Tunnel diodes oscillating above 3 kmc, designated Type D4115A, are now in production at Semiconductor Div., Sylvania. Other TD's capable of

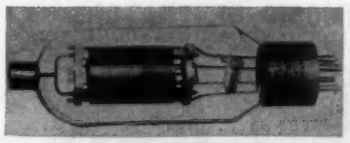


4 kmc oscillation now under development by the General Telephone & Electronic Laboratories, Inc., will be available from Sylvania in a few weeks. New diodes have a peak to valley ratio of 5 to 1; peak current to 4 ma at 50 mv; and min current at approx 350 mv. Inductance of 0.2 mμhenry is exceptionally low.—*Sylvania Electric Products Inc., a subsidiary of General Tel. & Electronics Corp., Woburn, Mass.*

CIRCLE 206 ON READER-SERVICE CARD

RUGGEDIZED TRIODE

New Type 572 Triode with specially processed graphite anode permitting 50% increase in plate dissipation over prototype 811A which it replaces, is further ruggedized by hard glass envelope, non-frangible filament and enclosed getter traps.



Designed for use in communications, ground support equipment, sonar, ultrasonics and other use requiring ruggedness and high reliability. Especially useful in zero bias Class B audio and SSB RF service.—*United Electronics Co., Subsid. of Ling-Altec, Inc., 42 Spring St., Newark, N. J.*

CIRCLE 207 ON READER-SERVICE CARD

TRANSMITTING ANTENNAS

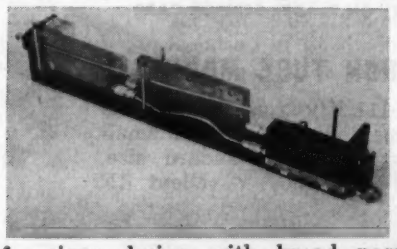
New Series TA spun-aluminum paraboloid transmitting antennas give maximum frequency coverage for each reflector with a minimum number of interchangeable feeds. Designed for

rugged instrumentation applications, they feature high gain; optimum side lobe-bandwidth characteristics; optimum impedance-bandwidth characteristics, and easily interchangeable feeds; range from 1′ to 10′ diameter. —*Scientific-Atlanta, Inc.*, 2162 *Piedmont Rd., N. E., Atlanta* 9, *Ga.*

CIRCLE 208 ON READER-SERVICE CARD

MICROWAVE SUB-SYSTEM

New coaxial line sub-system package, designed for use in "C" or "X" bands, contains an octave wide directional coupler, two band pass filters

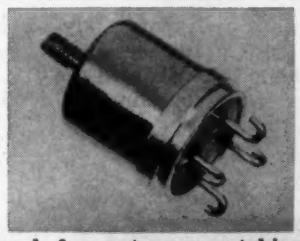


of unique design with broad pass bands and very sharp skirt selectivity, and a standard Merrimac flat coaxial attenuator (Type AE-6 IL attenuator for "C" band, AF-6 IL attenuator for "X" band).—*Merrimac Research and Development, Inc.*, 517 *Lyons Ave., Irvington* 11, *N. J.*

CIRCLE 209 ON READER-SERVICE CARD

WIDE BAND TRANSFORMER

New Type 1214 wideband RF transformer covers a range from 1.5-130 mc, with impedance ratio of 75 ohms unbalanced to 600 ohms balanced.

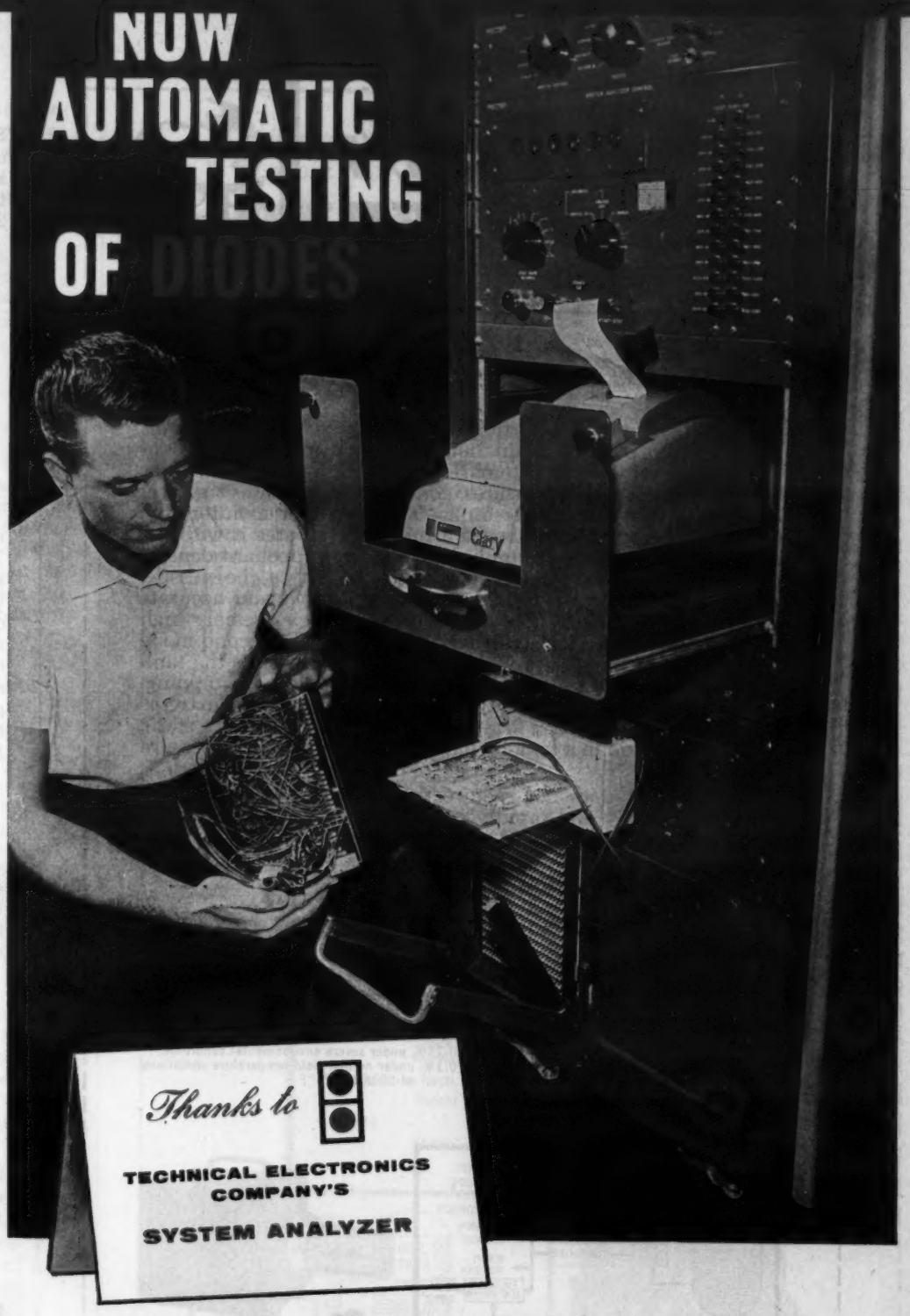


Designed for antenna matching, interstage coupling, impedance matching, computer drive circuits, pulse applications voltage step-up and dc isolation, the transformers are hermetically sealed mount with a single 4-40 stud. Case is ⅝" OD x ⅝" long. —*North Hills Electronics, Inc., Glen Cove, L. I., N. Y.*

CIRCLE 210 ON READER-SERVICE CARD

CIRCLE 58 ON READER-SERVICE CARD ⟶

NUW AUTOMATIC TESTING OF DIODES



LOCKHEED'S MISSILES AND SPACE DIVISION AT SUNNYVALE CHECKS OUT SOLID STATE PRINTED CIRCUIT BOARDS INCLUDING DIODES TEN TIMES FASTER

"We believe this is the first time diodes have been checked this way, on an automatic tester using AC, with an impedance bridge."

L. C. Sundstrand, Lockheed

TECHNICAL ELECTRONICS COMPANY
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Automation data now available for your file explains the many applications of complete automatic testing. For your copy, turn to the inquiry card and circle the number below.

Engineering notes from the **SM/I REPORTER**

BY STANLEY M. INGERSOLL, *Capabilities Engineer*

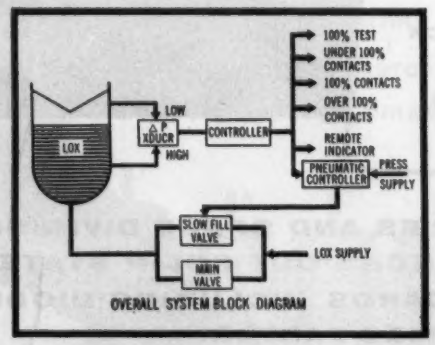
Report No. 9
TMC 601 LOX Tanking Computer System

Typical of our extensive participation in missile fuel management is our TMC 601 the main building block in the process of obtaining a completely automatic propellant loading system for missiles. It accurately measures, controls and indicates the level of liquid oxygen in missile tanks. The computer monitors the weight of the propellant aboard a missile, compares it with the desired weight, allows for tank diameter and propellant density correction and controls the flow of propellant to the missile. A two mode control system facilitates the rapid and accurate loading of the missile. The first mode permits extremely high pumping rates until 98% capacity is reached. The second mode then controls a precise proportioning valve which fills the tank to within 0.1% accuracy and provides for continuous topping. Entirely encased in a protective cover to withstand the extreme conditions generated by a firing, the TMC 601 measures the static head of the liquid in a tank by means of a highly refined pressure transducer.

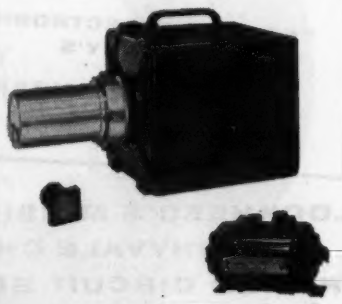
The TMC 601 does not require calibration after installation and can be easily and rapidly modified for new missile or tank configurations.

Typical Performance Specifications

Input Power	115 volts, 400 cycles, 15 watts 28 volts D.C., 2 Amps. 115 volts, 60 cycles, 100 watts (heater) 25 PSIG—clean, dry air-pneumatic supply to TR 2013
Pressure	1) Differential Pressure (liquid head) 10 PSIG (Range from 0.5 PSIG to 22 PSIG available) 2) Line Pressure 50 PSIG 3) Proof Pressure 90 PSIG
Accuracy	±0.25% under severe environmental conditions ±0.1% under normal field temperature conditions of 50°F to 125°F



OVERALL SYSTEM BLOCK DIAGRAM



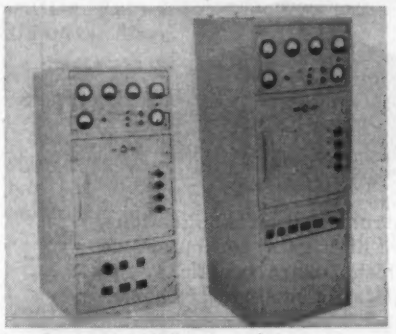
For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

SM/I SERVOMECHANISMS/INC.
Los Angeles Division
12500 Aviation Boulevard
Hawthorne, California

CIRCLE 59 ON READER-SERVICE CARD

SCATTER AMPLIFIERS

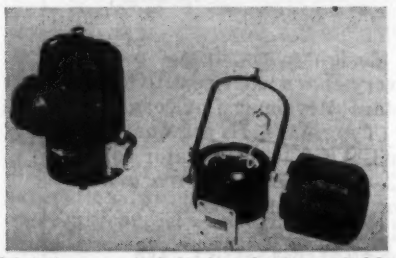
New UHF Power Amplifiers for Scatter Communications utilize 4-cavity air-cooled, permanent magnet klystron for 1 kw output power in the 1700-2400 mc range. Type 240F-2A (left) is transportable and operates from 380-420 cps primary power; Type 240F-2B is designed for fixed station scatter operation, operates from 47-63 cps power. Both may be operated synchronously tuned for a minimum power gain of 55 db and bandwidth of 2.5 mc or tuned for maximum efficiency with a power gain of 40 db and a bandwidth of 12 mc.—*Texas Div., Collins Radio Co.*, 1930 *Hi-Line Drive, Dallas 7, Texas.*



CIRCLE 211 ON READER-SERVICE CARD

KLYSTRON TUBE MOUNTS

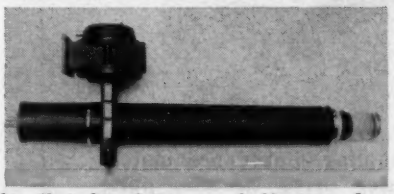
New DB-111 Klystron Tube mounts provide a method of coupling a small reflex klystron to a standard size, pressurized waveguide. Excellent RF shielding and full insulation of klystron shell for personnel safety are featured.—*DeMornay-Bonardi*, 780 *Arroyo Parkway, Pasadena, Calif.*



CIRCLE 212 ON READER-SERVICE CARD

BROADBAND POWER KLYSTRON

New 2 megawatt peak power klystron amplifier with a 100 mc bandwidth in the L-band is designated the L-3270 Klystron. Minimum gain of 30 db, flat bandpass and linear phase shift characteristics result from new "Skirtron" bunching techniques originated by the manufacturer.—*Electron Tube Div., Litton Industries*, 960 *Industrial Rd., San Carlos, Calif.*



CIRCLE 213 ON READER-SERVICE CARD

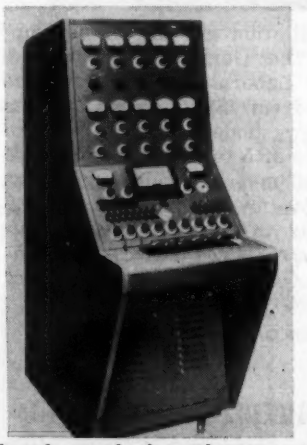
MAGNETRON BOWL-MAGNET

New Bowl-magnet design for G-E voltage-tunable magnetrons is available on a custom basis to any of the tubes in General Electric's VTM family operating in S-, L- and X-bands. Shown is new Z-5337 VTM, a complete RF power source in the 2.9-3.1 kmc range, with a diameter slightly over 3", height less than 1" and weighing 1.5 lbs. Its power output of 4 watts (min) may be electronically tuned over all or part of the range.—*Power Tube Dept., General Electric Co., Schenectady 5, N. Y.*

CIRCLE 214 ON READER-SERVICE CARD

INDUSTRIAL TUBE TESTER

Complete standard mutual conductance tests for Industrial Type Electron Tubes can be provided on a fully automated or manual basis for accuracies to 2%. 13 multi-range meters permit tube analysis under any standard or non-standard operating condition.—4-page Model 100 brochure describes.—*Westmore, Inc.*, 137 *South Ave., Fanwood, N. J.*



CIRCLE 215 ON READER-SERVICE CARD

HARMONIC GENERATORS

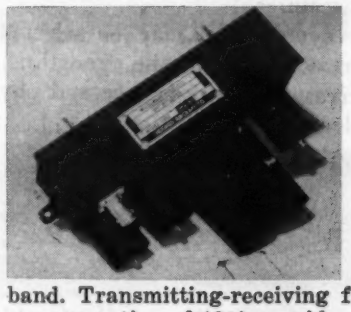
Ten new solid-state harmonic generators which provide efficient generation of second, third, fourth, and fifth harmonics with output frequencies ranging from L-band (1.30-1.43 KMc) to V-band (53.0-80.0 kMc) are

broadband, fixed-tuned, and have filters to eliminate unwanted harmonies. They utilize versatile coaxial, waveguide, and strip-transmission line packaging. High output power with conversion losses well below existing devices for harmonic generation is claimed.—*Microwave Associates, Inc., Burlington, Mass.*

CIRCLE 216 ON READER-SERVICE CARD

UHF MISSILE DIPLEXER

New Model U401 diplexer permits a 100-watt transmitter and sensitive receiver to be operated simultaneously with a single antenna in the 225-400

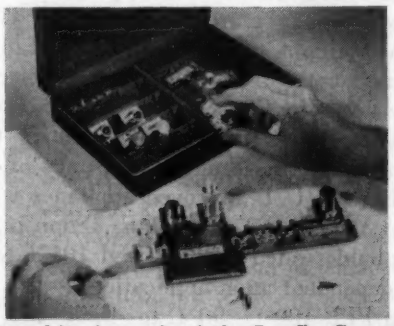


mc band. Transmitting-receiving frequency separation of 10% provides isolation in excess of 100 db, yet insertion loss between transmitter and antenna is only 0.2 db with a VSWR of 1.1.—*Hughes Aircraft Co., Components Div., Florence Ave. & Teale St., Culver City, Calif.*

CIRCLE 217 ON READER-SERVICE CARD

MICROWAVE BREADBOARD

Standard Modular Microwave components to fit TRI-PLATE® strip transmission lines are available in



four kits in each of the L-, S-, C- and UHF frequency bands. Standard kit for S-band is illustrated. "Circuit-Mated" kits to meet electrical and mechanical specifications for a specific circuit diagram are also available. —*Sanders Associates, Inc., 95 Canal St., Nashua, N. H.*

CIRCLE 218 ON READER-SERVICE CARD

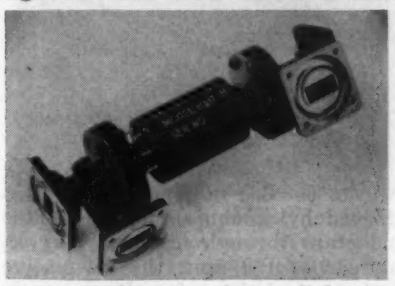
NEW FERRITE COMPONENTS

New C-band ferrite microwave devices featuring broad bandwidth low insertion loss, wide temperature range, small size and low weight include electrically variable attenuator, electrically variable phase shifter, and Y circulator.—*Red Bank Div., The Bendix Corporation, Eatontown, N. J.*

CIRCLE 219 ON READER-SERVICE CARD

FERRITE SWITCH

New Ku-band high-power fast ferrite switch enables two microwave antennae to be time-shared by a common transmitter and receiver, maintaining high isolation between the magnetron and load. Model R-107H

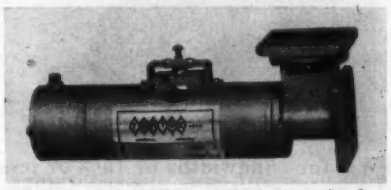


100 Kw peak power fast-switch operates over a 2% band between 15.7 and 16.9 mc., with loss of only 0.5 db, maximum VSWR of 1.20 and isolation between ports greater than 20 db. Switching at speeds under 10 μsec is performed using less than 70 watts peak power.—*Ferrotec, Inc., Newton, Mass.*

CIRCLE 220 ON READER-SERVICE CARD

FERRITE X-BAND SWITCH

New Model S X-102 Ferrite Switch for the 9.0-10.2 kmc band features isolation of 25 db min and less than 1.0 db insertion loss. Switching time

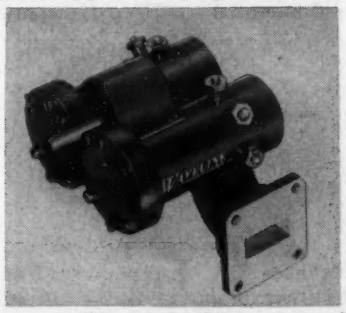


is 0.1 μsec. This unit is typical of Rantec Ferrite Switch line available also with associated drivers, in production quantities.—*Rantec Corporation, Calabasas, Calif.*

CIRCLE 221 ON READER-SERVICE CARD

WAVEGUIDE FILTERS

New tunable two section dual TE_{111} mode preselector filter designed for operation in the 8500 to 9600 mc range is typical of mfgrs. line of mi-



crowave filters. A 30 mc nominal bandwidth is provided at an inseration loss of 1.8 db max and rejection of 55 db min at F₀ +60 mc and 40 db min at F₀ −60 mc. 4 page brochure with specs for quotation request is available.—*Waveline, Inc., Caldwell, N. J.*

CIRCLE 222 ON READER-SERVICE CARD

Engineering notes from the **SM/I REPORTER**

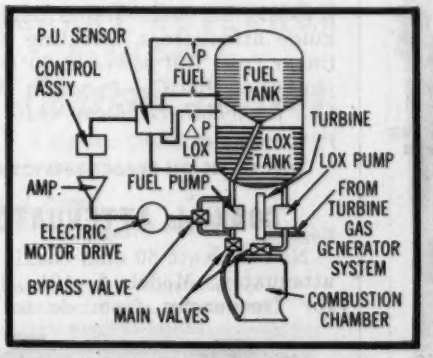
BY STANLEY M. INGERSOLL, *Capabilities Engineer*

Report No. 10
AQC 600 Propellant Utilization Control System

For maximum efficiency from a liquid propellant missile, fuel and oxidizer must be depleted simultaneously. Our new AQC 600 system, which consists of a controller and a differential pressure ratio sensor, measures the pressure ratio of fuel and liquid oxygen remaining in the tanks of a missile at any given time – then accurately controls the flow of these propellants into the combustion chamber. The percentage of accuracy is based on the propellants remaining in each tank, not on the full scale quantity. This reduces the absolute error signal as the propellant levels are decreased. The SM/I system measures the liquid head of each propellant and computes the ratio between the two head pressures electromechanically. An amplified error signal actuates a valve that changes the relative flow between fuel and liquid oxygen until the error signal is reduced to zero.

Typical Performance Specifications

Pressure Conditions		
Max. line pressure	120 psig	
Max. differential pressure	35 psid	
Min. differential pressure	0.2 psid	
Ambient	0-15 psi	
Gaseous medium	Gox, Helium, N_2, Air or H_2	
Electrical		
Input	115 volts, 400 cps, 10W 28 VDC – 1 amp.	
Heater Voltage (used only below 35°F)	28 VDC – 30 watts	
Environment		
Vibration	10-38 cps ±20 g's 38-2000 cps ±20 g's	
Shock	30 g's	
Acceleration	15 g's (one axis)	
Accuracy (on basis of ratio)		
Sensor	±0.5%	Computer...±0.15%
Weight		
Sensor	3.8 lb	Controller...4.8 lb



Photograph and over-all system diagram

For more information and complete operating specifications, write or wire SM/I today. Address your inquiry to Stanley M. Ingersoll, Capabilities Engineer.

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CIRCLE 61 ON READER-SERVICE CARD

"EXPENDABLE" COAX LOAD

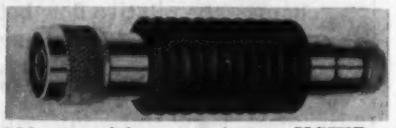
New coaxial load in 1⅝" dia, 50 ohm EIA line, developed for use with balanced duplexes in radar systems, can dissipate an average power of 20 watts at 20 kw peak. Has max

VSWR over the 400-450 mc range. Designed as an expendable component, its price is relatively low.—*Bomac Laboratories, Inc., Salem Road, Beverly, Mass.*

CIRCLE 223 ON READER-SERVICE CARD

HIGH POWER ATTENUATOR

New AD series coaxial microwave attenuators with an input power rating of 15 watts operate from dc to



4000 mc with a maximum USWR of 1.20. Values of 3, 6, 10, 20, 30 and 40 db are available from stock. The AD attenuators consist of two or more tee section pads properly cascaded to distribute the power dissipation. Cooling fins minimize temperature rise.—*Microlab, 570 W. Mount Pleasant Ave., Livingston, N. J.*

CIRCLE 224 ON READER-SERVICE CARD

ATTENUATOR DISCS

New line of high power, deposited carbon film coaxial attenuator discs allow more power dissipation per unit area at higher pulse voltages. Ideal for use in terminations, attenuators, coaxial line attenuators and waveguide attenuators. Derating curve is linear from full power at 70°C to zero power at 150°C.—*Pyrofilm Resistor Co., Inc., U.S. Highway #45 Parsippany, N. J.*

CIRCLE 225 ON READER-SERVICE CARD

COAXIAL ATTENUATOR

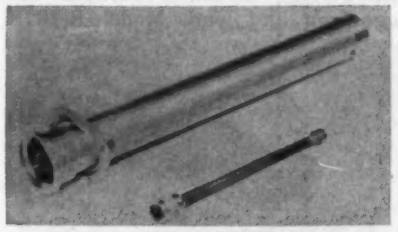
New 10 watt 50 ohm coaxial power attenuator, Model A 101, designed for frequencies from dc to 4 kmc

is available in attenuation values from 0 to 60 db. Accuracy of attenuation to 30 db is ±⅛ db; from 30 to 60 db is ¼ db. VSWR over entire range is 1.3 max. Other attenuators up to 50 watts power rating are available.—*R L C Electronics, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.*

CIRCLE 226 ON READER-SERVICE CARD

COAXIAL TERMINATIONS

Smallest and largest of a complete line of broadband coaxial terminations covering the 500 mc to 12,500 mc range are illustrated. Ruggedness is



achieved by joining inner and outer conductors through a metal plug at the rear of the unit, the dissipative element consisting of a long, gentle taper of heat—and moisture—resistant lossy plastic.—*Radar Design Corp., Pickard Drive, Syracuse 11, N. Y.*

CIRCLE 227 ON READER-SERVICE CARD

VARIABLE ATTENUATOR

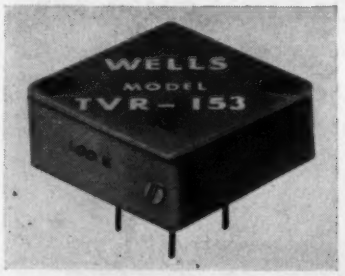
New miniature "S" band continuously variable attenuator designed primarily for airborne use is of the Pi Line Vamp type with full attenuation in less than 180° of revolution.

VSWR for bandwidths of 15% or less is 1.3 max on input end. Total attenuation is 20 db min at about 3 kmc. Power capacity is 10 watts average, 5 kw peak.—*Antenna & Radome Research Assoc., 27 Bond St., Westbury, N. Y.*

CIRCLE 228 ON READER-SERVICE CARD

TRIMMING POTENTIOMETER

Trimming Pot for Printed Circuits in missiles, telemetry, etc., designated TVR-150 series, can have pins side- or end-mounted, with adjustment



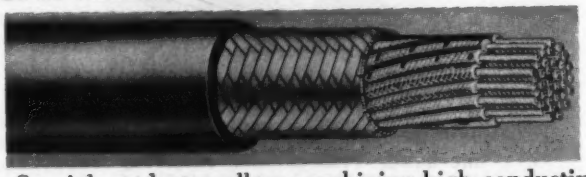
screw from the side or the top. Rated at 1 watt, TVR-150 series is available in 14 standard resistance ranges from 10 ohms to 100K, meets all MIL-Specs for temperature, shock and humidity.—*Wells Industries Corp., 6880 Troost Ave., No. Hollywood, Calif.*

CIRCLE 229 ON READER-SERVICE CARD

Electronic Cable Conductors and Insulations

Copper—with its high electrical conductivity, ductility, and ease of processing—is almost invariably specified as conductor material for wire and cable. For most low and medium temperature applications Electrolytic Tough Pitch (ETP) copper conductor is considered standard. However, for high temperature wire and cable utilizing Teflon insulation, Oxygen Free High Conductivity (OFHC) copper is frequently specified. OFHC minimizes conductor corrosion and embrittlement problems occasionally encountered at high temperatures.

Copper-covered steel may be selected for applications where additional tensile strength is required, and where increased D.C. resistance and physical stiffness can be tolerated.



Special conductor alloys combining high conductivity with high tensile strength, elongation, and flex life are available for "wrapped" connections. High temperature conditions up to 250°C continuous are readily met by silver plated conductors, with tin plating normally used at temperatures under 125°C for easy soldering and oxidation protection.

Insulation Materials

Teflon TFE (—90°C to +250°C). At the present time, Teflon TFE is the finest insulating material available for wire and cable applications. In addition to its wide temperature range, Teflon TFE is unaffected by sunlight, moisture, and practically all chemicals and/or corrosive atmospheres. Its electrical properties—Dielectric Constant (2.3) and Power Factor (0.0003)—are constant over its entire temperature range, and from dc to many thousands of megacycles.

Full lines of U/L approved appliance wire utilizing standard MIL-W-16878, Type E, Teflon insulation are now available, rated at 80°C and 105°C with voltage ratings dependent upon application.

Teflon FEP 100 (—90°C to +200°C), Teflon FEP 100 is Du Pont's designation for another fluorocarbon-derived insulating material. With the exception of a +200°C maximum temperature limit, its properties are similar to those described for Teflon TFE.

Since Teflon FEP can be extruded conventionally, its prime applications are for jacketing coaxial and multi-conductor cables. Its high processing rate at a lower temperature make FEP well suited for insulation over tinned copper-allowing the use of automatic soldering equipment in assembly. However, FEP-insulated tinned copper wire should be specified only where high ambient temperatures are not encountered.

Polyvinyl Chloride (—55°C to +105°C) The excellent dielectric strength and high degree of flexibility of PVC make it the most frequently specified hoop-up wire insulation. Its electrical characteristics usually do not permit its use at radio frequencies. Its Dielectric Constant (3.0-7.5) and Power Factor (0.005-

0.019) are comparatively high, and vary considerably with frequency. PVC is relatively susceptible to moisture penetration, and is affected by a number of chemicals, including the organic solvents.

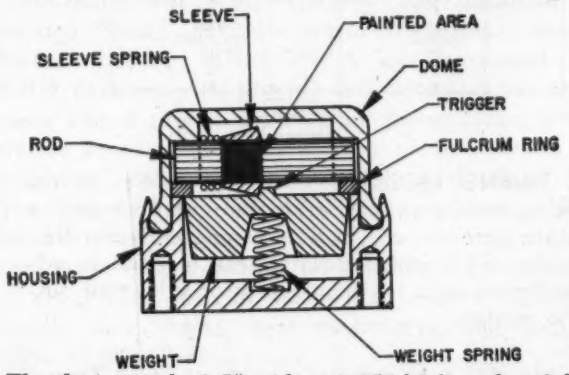
Xelon (−75°C. to +80°C) (High Molecular Weight Polyethylene) Xelon*® with all of the standard polyethylene qualities plus superior weathering ability, is a jacketing material excelled only by some of the fluorocarbon-derived compounds such as Teflon. (*From 18-page catalog "Multiconductor Cable & Hook-up Wire," Times Wire & Cable Co., Wallingford, Conn.*)

* Xelon,® Times Wire and Cable Co.

FOR THIS LITERATURE CIRCLE 230 ON READER-SERVICE CARD

Shock Overload Tell-Tale

A new shock overload indicator, Convair Instruments Series 37, is available to provide proof of excessive shocks during shipment of delicate or sensitive equipment, to provide checks on unnecessary roughness in handling methods and to educate personnel in handling methods. It is also applicable in the monitoring of production shock tests and to indicate acceleration-deceleration levels in shock testing.



The device, only 1.5" wide x 1.75" high and weighing about ¼ lb, operates mechanically without the use of batteries or magnets. Shown in cross section (See Figure) the indicator consists of a rod having a painted portion which is normally obscured by a spring-loaded sleeve. This sleeve is held in the cocked position by means of a small trigger which is an integral part of a weight supported in the cocked position by a spring. The mechanism is enclosed in an anodized aluminum housing with a transparent dome which enables an observer to see if the indicator has been tripped.

If the weight is displaced sufficiently to disengage the sleeve from the trigger, the coiled spring forces the sleeve along the rod to uncover the painted portion. The Series 37 Shock Overload Indicator is sensitive to accelerations in the longitudinal (top to bottom) axis, and to any acceleration in a plane transverse to this axis. Detailed information as to response to a particular set of variables can be supplied on request.

The Shock Overload Indicator can be used again after operation. It is reset by inserting a wire through a hole in the dome which is protected during use by screws, safety wire and an inspector's seal to prevent unauthorized setting.—(*From 5-page bulletin No. 37-1, Convair Instruments Division, General Dynamics Corp., 3595 Frontier St., San Diego 10, Calif.*

FOR THIS LITERATURE CIRCLE 231 ON READER-SERVICE CARD

ULTRASENSITIVE POT

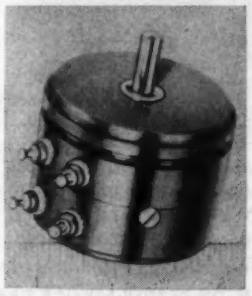
New Model 111 Linear Motion Potentiometer provides without amplification outputs up to 350v/inch of displacement. Capability of detecting mo-

tions as small as 0.000005" with life rating to 30-million strokes makes it an important component in controlling linear positions. Available in stroke length from ¼" to 10", in capacities of 1 watt per inch of stroke. —*Computer Instruments Corp., 92 Madison Ave., Hempstead, L. I., N. Y.*

CIRCLE 232 ON READER-SERVICE CARD

SINE-COSINE POT

New 17XT Precision Potentiometer, designed as TACAN phase-shift component, has application wherever sine and cosine output voltages must be

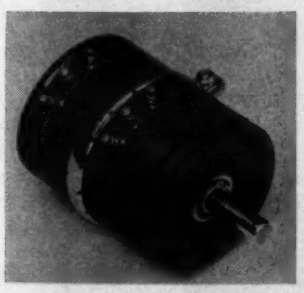


simultaneously produced. Complete specs available.—*The Gamewell Co., 1238 Chestnut St., Newton Upper Falls 64, Mass.*

CIRCLE 233 ON READER-SERVICE CARD

HIGH RELIABILITY POT

New 1⅝" precision potentiometers, combining high temperature operation with extremely long load life, have been laboratory and field tested for



nearly two years. All standard resistance values are manufactured with 20 ppm resistance wire and can dissipate 2 watts at 125°C for more than 2,000 hours. Up to 16 taps to ±0.25° can be provided. Meets applicable MIL-SPECS.—*Carter Manufacturing Corp., 23 Washington St., Hudson, Mass.*

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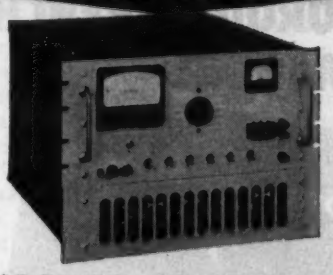

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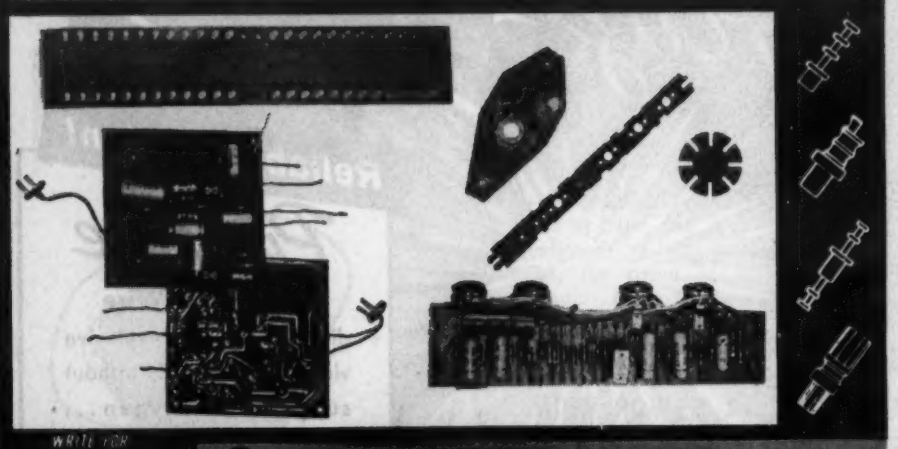
RESISTOR and TERMINAL BOARDS
TERMINALS and SUB-ASSEMBLIES



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CIRCLE 67 ON READER-SERVICE CARD

SIDE-ADJUSTING SUBMIN POT

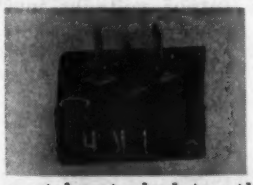
New Wee Round Model 520 encloses circular wirewound mandrel in aluminum housing ½" diameter, 1/5" thick and weighing less than 2 grams.

40-to-1 worm and gear adjustment screw projects from side of housing to give 360° rotation, high setting stability. Resistance values are from 10 to 50 Kohms, meets MIL-E-5272A. —*Handley, Inc.*, 12960 *Panama St., Los Angeles* 66, *Calif.*

CIRCLE 235 ON READER-SERVICE CARD

PRINT-CKT POT

A height-off-board of only 0.195" is now provided by the new Series 312 Squaretrim pots, which is particularly useful when printed circuit



boards must be stacked together into modular assemblies. Full information and data on request.—*Daystrom, Inc., Pacific Div.*, 9320 *Lincoln Blvd., Los Angeles* 45, *Calif.*

CIRCLE 236 ON READER-SERVICE CARD

SUBMIN RATE GYRO

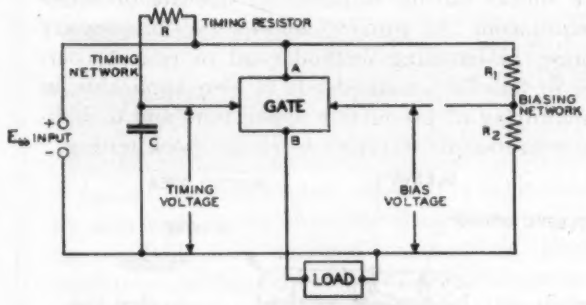
New 6-oz type M-100 rate gyro that provides constant dumping without heaters from −65°F to 250°F is said to be suited for advanced military aircraft and guided missiles, also

for autopilot damping, radar antenna stabilization and control installations. Quadrilever spring used for torsion restraint is said far superior to torsion bars in resistance to shock and vibration.—*Boston Div., Minneapolis-Honeywell Regulator Co.*, 40 *Life St., Boston* 35, *Mass.*

CIRCLE 237 ON READER-SERVICE CARD

Effect of Noise on Timing Module Accuracy

Controlled Solid State Timing Modules typically consist of an RC timing network, a resistance divider biasing network and the transistorized gate circuit (See Figure). The load may be a relay, solenoid, stepping switch or other digital logic element. Upon application of operating voltage, bias on the gate is immediately established by the voltage dividing action of R_1 and R_2. At the same instant of time, the timing capacitor C starts charging exponentially through the timing resistor R. When the timing voltage across C equals the bias voltage, the gate triggers and a voltage step is applied to the relay, causing actuation of the relay. Accuracy of the time delay is independent of the relay characteristics.



BASIC TIMING MODULE consists of an RC timing network, a resistance divider biasing network and a solid state gate circuit. In fixed timing units the timing resistor (R) is included within the module; in adjustable-timing units the timing resistor is located outside the module.

Considerable field experience with standard Tempo Time Delay Relay units has demonstrated that they perform completely within the guaranteed specifications because the power supply is usually well controlled. However, if there is uncontrolled noise or ripple riding the supply voltage during the timing cycle, the delay time may be affected.

For example: If the noise on the line is of such a nature that it momentarily depresses the voltage (negative "spikes"), then the bias presented by R_1 and R_2 to the gate will also be reduced momentarily by the voltage divider ratio. If the capacitor has now charged enough so that the bias is momentarily less than the capacitor voltage, the gate will fire. Thus, these voltage depressions usually shorten the delay time.

The larger in magnitude the depressions are, the sooner the gate fires. However, with this type of noise on the line, not only is the bias momentarily depressed, but the charging rate of the capacitor is reduced while the voltage depression is present. The change in the delay time is not a simple function depending only upon the magnitude of the depression; it depends upon the duration as well.

If the noise riding the DC supply is such that the voltage is momentarily increased (positive "spikes"), the bias will be increased also. However, with the increase in voltage, the charging rate of the capacitor will also increase. The circuit may fire prematurely

when the supply voltage drops from the peak of the noise present to the average DC level. Here again, the net effect is usually a shortening of the delay time.

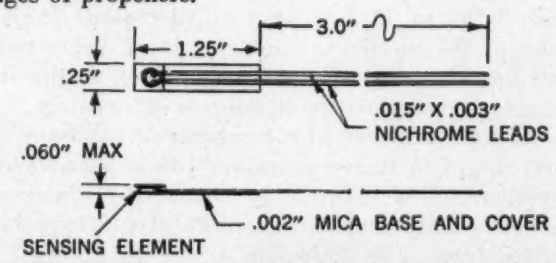
Another type of disturbance that can affect the timing occurs when the voltage is high to begin with and then drops suddenly. This might be caused by a poor regulator and sudden application of a load. Depending upon the magnitude of the voltage drop and the capacitor voltage, the gate may fire instantly, or the delay time will be shortened. Conversely, a step function increase in voltage will lengthen the delay time.

In summary, noise or disturbance on the line can either shorten or lengthen the delay time depending upon waveform, magnitude, repetition rate, etc. For a particular application where noise is present, these factors must be taken into account. (*From* 16-*page Engineering Bulletin* 5906, *Tempo Instrument Inc., P. O. Box* 338, *Hicksville, N. Y.*)

FOR THIS LITERATURE CIRCLE 238 ON READER-SERVICE CARD

Surface Transducer Measures ICBM Temperatures

Miniature size and extremely fast response of Nacimo Model TT-1315 Series temperature transducers, meeting MIL-E-5272-A and approved for ICBM environments, provide designers and test engineers with a precision resistance thermometer which almost becomes an integral part of the surface to which is is attached. Correctly installed, the 3/16" disc transducer can be applied to any surface, with a maximum temperature of 1000°F as the only limitation. Applications include temperature measurements of cryogenics, aircraft wings and control surfaces, missile skins, tanks, heat exchangers, and leading edges of propellers.



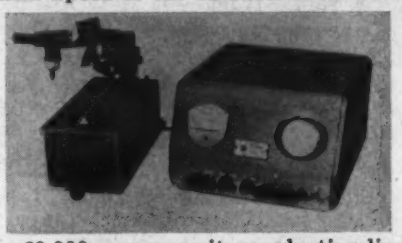
Each transducer is supplied calibrated at 5 points within the temperature measurement range, accurate to 0.1°F. Operating maximum temperatures are available from 100°F to 1000°F. Time constants are directly related to transducer insulation coating thickness and the addition of the optional guard. Uncoated elements respond to step functions in 10 msec. Where high speed flow environments are encountered, it is advisable to provide the element with an insulating coating. Application details should be specified.

In addition to the Model TT-1315-1 with removable mica shield, shown in the accompanying figure, the sensor is also provided as Model TT-1315-2 for use with Englehard or equivalent cement, and as Model TT-1315-3 on a weldable stainless steel tab. Special arrangements can be made to meet a typical requirements specifiied by the customer. (*From* 2-*page catalog sheet, TT*-1315 *Series, Nacimo Products,* 1090 *Morena Blvd., San Diego* 10, *Calif.*)

FOR THIS LITERATURE CIRCLE 239 ON READER-SERVICE CARD

DYNAMIC BALANCER

A new dynamic balancer determines unbalance vibrations as small as one-quarter of one-millionth of an inch. Speed of the balancer from 8000



to 60,000 rpm permits production-line precision balancing of miniature gyro rotors and other electromechanical devices.—*Micro Balancing, Inc., Hericks Rd., Garden City Park, N. Y.*

CIRCLE 240 ON READER-SERVICE CARD

MINI FLOATED GYRO

New high precision miniature floated gyro with trimmed drift rate of less than 0.01°/hr is identified as

the Reeves ZERO ONE series. Having a case diameter only 1.8", angular momentum of 300,000 cgs units and a mass unbalance of less than 0.4°/hr/G is claimed.—*Reeves Instrument Corp., Subsidiary of Dynamics Corp. of America, Garden City, N. Y.*

CIRCLE 241 ON READER-SERVICE CARD

POTENTIOMETER ACCELEROMETER

New potentiometer type accelerometer uses flexures and dual seismic masses providing a seismic mechanism with no rubbing parts and minimum cross-talk. Unit damped with silicone fluid meets Navy Spec

1369283 with linearity at ± 2% from —55°C to 70°C and error due to vibration less than 6% under 10G, 55 to 500 cps and ± 0/.030" displacement at 10-55 cps.—*Dynamic Devices, Inc.,* 3170 *Valleywood Drive, Dayton* 20, *Ohio.*

CIRCLE 242 ON READER-SERVICE CARD

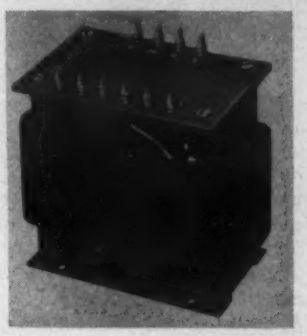
FUSION SEALED RESISTOR

New glass-enclosed resistor that defies moisture exceeds performance requirements of MIL-R-10509C, Characteristic B. Data sheet CE-202 available on request.—*Corning Electronic Components, Corning Glass Works, Bradford, Pa.*

CIRCLE 243 ON READER-SERVICE CARD

CONSTANT VOLTAGE TRANSFORMER

New Freed 500 VA Constant Voltage Transformer maintains an output of 115 v with an input of 95 to

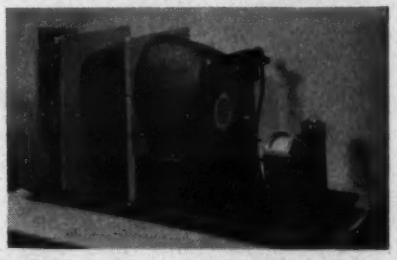


130 v 60 cps; can be hermetically sealed for military applications.—*Freed Transformer Co., Inc.,* 1718 *Weirfield St., Brooklyn* 27, *N. Y.*

CIRCLE 284 ON READER-SERVICE CARD

THERMAL RADIATION TESTER

New instrument tests inflammability of materials exposed to thermal energy of exactly known intensity.

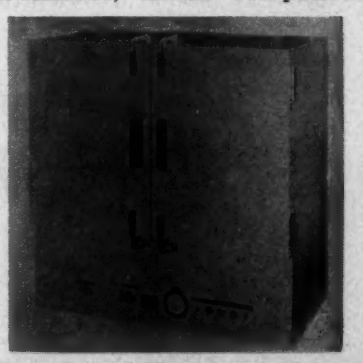


Radiation intensity is adjustable to any value to 10 watts/cm² corresponding to 2.5 cal/cm² sec or 33,200 BTU/ft²/hr. Thermocouple measures radiation directly, precise moment of ignition is signalled by extinguishing of indicator lamp and measured by stop watch.—*EPIC, Inc.,* 150 *Nassau St., New York* 38, *N. Y.*

CIRCLE 285 ON READER-SERVICE CARD

CONSTANT TEMPERATURES

New Constant Temperature cabinets, used in storage and protection of heat-sensitive, missile components



such as gyros and velocity meters, are built to Navy Specs. Also provide safety alarm circuits and special loading systems.—*Precision Scientific Co.,* 3737 *W. Cortland St., Chicago* 47, *Ill.*

CIRCLE 286 ON READER-SERVICE CARD

DRAFTING AIDS

Printed circuit drafting aids for making paste-up layouts for Master Drawings are listed with specifica-

tions and illustrations in new six-page reference chart, Bulletin No. P-30.—*By-Buk Co.,* 4314 *West Pico Blvd., Los Angeles* 19, *Calif.*

CIRCLE 280 ON READER-SERVICE CARD

FLOATING AC VTVM

New Model 109-2 low level, portable laboratory instrument has signal circuits isolated from case and power line, allowing floating measurements between any two points in a circuit. —*Trio Labs, Inc., Plainview, L. I., N. Y.*

CIRCLE 194 ON READER-SERVICE CARD

HI-VOLTAGE Si RECTIFIERS

New silicon cartridge rectifiers (IN 1730, IN2373, IN2383 and IN-1133 Series) covering 600 PIV to 16,000PIV have average rectified current ratings ranging up to 250 ma @ 25°C with maximum surge ratings of greater than 2.5 amp for 8 milliseconds. Operating temperatures from —55°C to 150°C. Voltages to 21,000PIV are available on request. —*Semiconductor Division, General Instrument Corp.,* 65 *Gouverneur St.,* Newark, 4, *N. J.*

CIRCLE 195 ON READER-SERVICE CARD

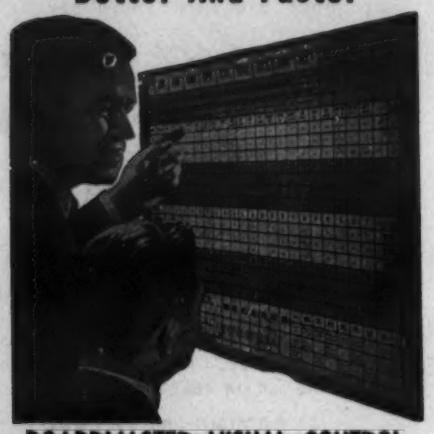
COMPACT BLOWER

New MSA-11000 vane-axial blower unit, with a nominal air delivery rat-

ing of 350 cfm at a static pressure of 5.8" H_2O, is only 7" dia. 6.20" long.—*Specialty Blower Div., The Torrington Manufacturing Co., Torrington, Conn.*

CIRCLE 196 ON READER-SERVICE CARD

How To Get Things Done Better And Faster



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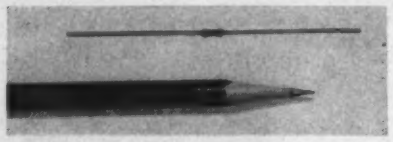
CIRCLE 70 ON READER-SERVICE CARD

SMALLEST (?) RESISTOR

Reminiscent of the song *"About as Fer as They Can Go in Kansas City"* from "Oklahoma!," is this new 1/10th watt carbon film precision resistor,



only 0.250" long x 0.093" dia, furnished with a high temperature, impact and moisture resistant coating. Extra molded jacket for protection against mechanical abuse can also be provided.—*Electra Mfg. Co.*, 4051 *Broadway, Kansas City, Mo.*

CIRCLE 244 ON READER-SERVICE CARD

BOUNCELESS VARIABLE RESISTORS

Model 7 Radiohms®, featuring zero contact bounce under vibration of 20-2000 cps at 30 G for 10 minutes in each of three planes, are linear motion variable resistors built for ultra-

high reliability applications, yet having component density of 9/cu-in. Wirewound units cover range from 100 to 20K ohms, composition units from 10K to 2.5 megohms, in completely corrosion resistant construction.—*Centralab Div. of Globe-Union, Inc.*, 900 *E. Keefe Ave., Milwaukee* 1, *Wisc.*

CIRCLE 245 ON READER-SERVICE CARD

HI-POWER RESISTOR DECADE

New Clarostat Model 240C Power Resistor Decade Box allows changing resistance in a working circuit without resistance breakdown between settings, thus protecting delicate meters

and other instruments and components in the circuit. Any resistance from 1 to 999,999 ohms at a max power rating of 225 watts, using a maximum of 1000 v dc or 660 v ac, may be selected.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

CIRCLE 246 ON READER-SERVICE CARD

HIGH STABILITY INDUCTOR

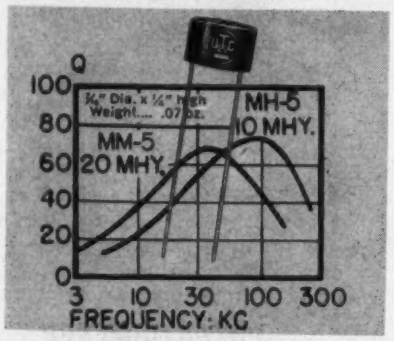
New "THERM-L" inductor, a high-Q fixed inductor having very stable inductance and Q characteristics over a range from —55°C to 375°C with

good retrace characteristics, is available in a close tolerance range from 0.068 μh to 0.56 μh. Meets Class C operation requirements of MIL-C-15305A.—*Essex Electronics Div., Nytronics Inc.*, 550 *Springfield, Ave., Berkeley Heights, N. J.*

CIRCLE 247 ON READER-SERVICE CARD

MINI TOROID INDUCTORS

"MINIDUCTOR" series MM-5 through MM-8 and MH-5 through MH-8 now provide inductance values (at 0 direct current) from 3 to 120 mhy in the MM series, 0.6 to 40 mhy in the MH series. Feature low

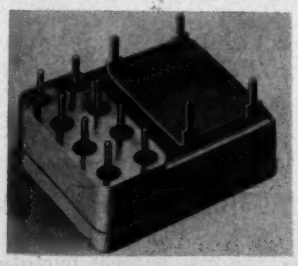


hum pickup, high-Q in miniature form for printed circuit and transistor applications. Meet MIL-T-27A type TF5RX20ZZ; terminal spacing is 21/64".—*United Transformer Corp.* 150 *Varick St., New York* 13, *N. Y.*

CIRCLE 248 ON READER-SERVICE CARD

PRINT-CKT RELAY

Compact Style 6A microminiature DPDT relay, designed to minimize height of printed circuit components, occupies 20% less space of circuit board area; has installed height approx 0.44". Terminals and mounting tabs are on 0.2" grid pattern.



Suitable for low-level and power circuits to 2 amp resistive at 26.5 v dc or 115 v ac, meets applicable MIL-Specs.—*Price Electric Corp., Frederick, Md.*

CIRCLE 249 ON READER-SERVICE CARD

"Dice" Sub-Module is Used in New Computer

Packing density of 250,000 parts per cubic foot is claimed for a new half-inch cube module being used in the guidance system of the AN/USD-4 "Swallow" reconnaissance drone being built for the Army Signal Corps by the Republic Aviation Corp., Missiles Systems Division, Mineola, N. Y. Each die holds from

DICE SUB-MODULES used in modular card held in engineer's left hand accomplish same work as the 23 conventional printed circuits spread on the table.

12 to 18 components, and their small size permits the use of 44 to 50 dice per computer card. The small size of the Swallow computer, only 2 cubic feet including the memory drum, is credited to the small, uniform conformation of the new sub-module.

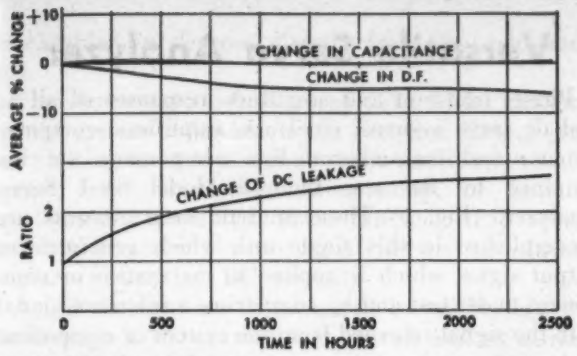
The use of standard components of proven reliability, including high-temperature silicon semiconductor components, is expected to enable the computer to perform with complete reliability over a temperature range from —70°F to 240°F.

FOR MORE INFORMATION CIRCLE 250 ON READER-SERVICE CARD

Solid Tantalum Capacitor

The "Aerotan" solid tantalum capacitor, characterized by a solid electrolyte, porous sintered tantalum anode, and hermetically sealed subminiature case, is a fixed polarized capacitor intended for military, industrial and commercial use. Designed for relatively low working voltages, 6 to 23 vdc, the Aerotan capacitor provides as much as 330 μf in a package only ¾" long by 0.341" diameter at the lowest voltage rating.

Because the electrolyte is completely dry and is hermetically sealed, no possibility of leakage or corrosion by electrolyte exists. They are particularly fitted for applications where the ac component is small compared to the dc voltage rating. The dc working voltage rating is maximum for continuous operation and at rated temperature should not be exceeded by



MINIATURE TANTALUM capacitors show characteristic changes in capacitance, dissipation factor (D. F.) and leakage current after life at 85°C and rated voltage.

the applied dc voltage plus the ac rms ripple (if any).

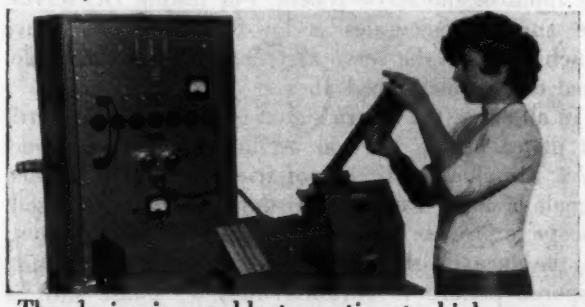
Aerotan capacitors are available in ST12 (uninsulated) and ST13 (insulated) types. The metal case provides the negative terminal. Typical Change of Capacitance, Dissipation Factor and Leakage Current curves showing changes after life tests at 85°C are shown above. Dissipation factor typically decreases with life, while dc leakage increases with life and with temperature, with maximum leakage limits as given in Table 1.—(*From 4-page catalog* 215/B2.1.—*Aerovox Corporation, New Bedford, Mass.*)

FOR THIS LITERATURE CIRCLE 251 ON READER-SERVICE CARD

Automatic Resistance Sorter Has High Accuracy

A new high speed resistance tester and sorter, designated Model AB-6-2, has a capability of 4000 pieces per hour. Resistors are automatically sorted into nine different resistance categories, in accordance with tolerance limits which can be set by means of plug-in units. Resistors falling into each category are segregated in a separate bin.

A built-in 7-dial resistance decade is provided for setting to the nominal value of the resistance being checked. The number of resistors in each bin are tallied by resettable electromechanical counters.



The device is capable to sorting to high accuracy over an exteremely high and low range to the following limits: From 10 to 100 ohms, ±0.3%: from 100 ohms to 2 megohms, ±0.1%, from 2 to 10 megohms, ±0.2%; and from 10 to 100 megohms, ±0.3%.

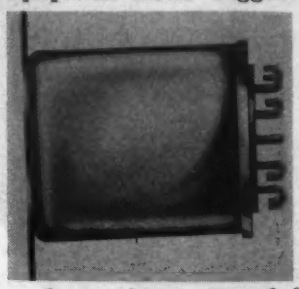
Components to be tested in this machine are inserted while packed in any of the standard paper or cardboard packaging strips in which they are stocked and handled.

The AB-6-2 tester is a development of the Industrial Instruments Automation Corporation, 89 Commerce Road, Cedar Grove, N. J.

FOR MORE INFORMATION CIRCLE 252 ON READER-SERVICE CARD

SMALL POWER RELAY

Small size, light weight relay RX-1307 for ground checkout and support equipment meets rugged envi-

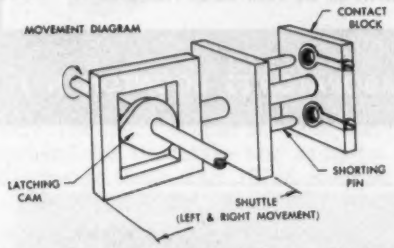


ronmental requirements of Signal Corps Std GS-4176-1 including shock resistance to 75G and temperatures —55° to 100°C. Handles 17.5 amps at 16.6 v dc to 100,000 operations at 100°C ambient.—*Wheelock Signals, Inc., Long Branch, N. J.*

CIRCLE 253 ON READER-SERVICE CARD

NON-MAGNETIC LATCHING RELAY

Solenoid-actuated, mechanically-locked contacts of new Type A-2A relay move like a shuttle to make and break contacts. The movable contact

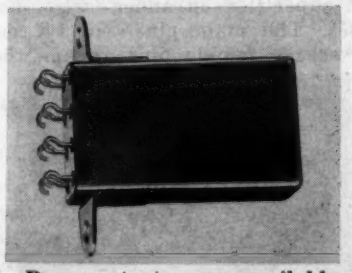


assembly is locked at three distinct points in either of the alternate switching positions, to eliminate contact chatter.—*Astromics Div., Mitchell Camera Corp., 611 W. Harvard St., Glendale, Calif.*

CIRCLE 254 ON READER-SERVICE CARD

SENSITIVE DC RELAYS

New type JSH High Sensitivity dc relays are available in SPDT and DPDT models with 25 and 40 mw sensitivities respectively. Contact ratings of 2 amp at 29v dc, 1 amp at 115 v ac, non-inductive are stand-



ard. Dry contacts are available on request. No contact chatter results from 5 to 55 cps vibration at 0.09" double amplitude, 15 G from 55 to 2000 cps, and shock at 50 G. Plug-in printed circuit or hooked terminals with 0.2" grid spacing are available. —*Allied Control Co., Inc., 2 East End Ave., New York 21, N. Y.*

CIRCLE 255 ON READER-SERVICE CARD

SATELLITE POWER SWITCH

Motor driven switch is teamed with voltage sensing element to switch from an exhausted battery to a fresh one or to solar power in extended

space flights. No contact chatter is shown from 5 to 2000 cps, 40 G, and voltage drop across typical switch contacts is less than 10 mv at 22 amps. No power is required to hold the switch open or closed.—*Kinetics Corp., 410 S. Cedros Ave., Solana Beach, Calif.*

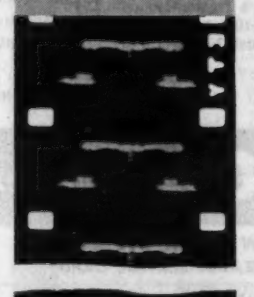
CIRCLE 256 ON READER-SERVICE CARD

PRINT-CKT CONNECTOR

New printed circuit connector maintains positive contact with a printed circuit board which can be polarized in any position by the insertion of a plastic polarizing key. It contains 44 contacts, which are phosphor bronze with a silver plate of 0.0002" and 0.00003" gold plate finish.—*Cinch Manufacturing Co., 1926 S. Homan Ave., Chicago 24, Ill.*

CIRCLE 257 ON READER-SERVICE CARD

Actual reproductions from FASTAX high-speed films, taken at 7,500 frames per second, used to analyze contact operation.



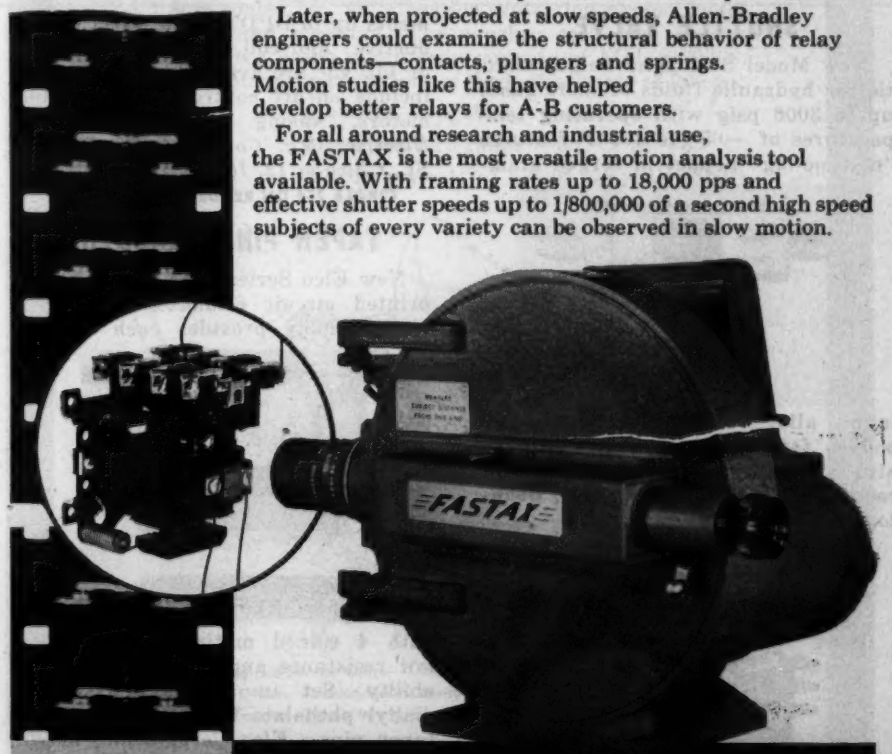
How Allen-Bradley uses *FASTAX* to check super-speed components

Allen-Bradley engineers had to *know* how contacts in their motor control relays stood up under stress, when operating too fast for the human eye to follow.

Using a FASTAX high speed motion picture camera, they *photographed* contact action and got a permanent, accurate record at a film speed of 7500 frames per second.

Later, when projected at slow speeds, Allen-Bradley engineers could examine the structural behavior of relay components—contacts, plungers and springs. Motion studies like this have helped develop better relays for A-B customers.

For all around research and industrial use, the FASTAX is the most versatile motion analysis tool available. With framing rates up to 18,000 pps and effective shutter speeds up to 1/800,000 of a second high speed subjects of every variety can be observed in slow motion.



WRITE for new descriptive literature.

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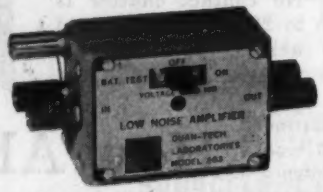
CIRCLE 71 ON READER-SERVICE CARD

NOISE RELIABILITY

In today's complicated systems and components, abnormal noise is an indication of unreliability. Four new Quan-Tech instruments, calibrated in absolute units, remove ambiguity in the basic field of noise measurements.

WAVE AND NOISE SPECTRUM ANALYZER. Model 303: For making rapid, accurate analysis of wave and noise spectra. Offers selection of four constant bandwidths, two flat-topped, 30 cps to 100 kc frequency range. A basic laboratory tool for noise investigation.



LOW NOISE AMPLIFIER. Model 203: A very low noise, self-contained, miniature transistor amplifier. Features a voltage gain of 100 and a frequency range of 30 cycles to 100 kc. Increases sensitivity of Model 303 to 1 microvolt full scale.

RESISTOR-NOISE TEST SET. Model 315: Meets recommended specifications of the National Bureau of Standards and the International Electrotechnical Commission for the measurement of noise in resistors.

Available Soon

TRANSISTOR NOISE ANALYZER. Model 310: Provides simultaneous analysis of transistor noise at three frequencies. System automatically corrects for variations in transistor gain. Beta, Icbo and Iebo are also included – providing measurements of essential transistor characteristics in one instrument.

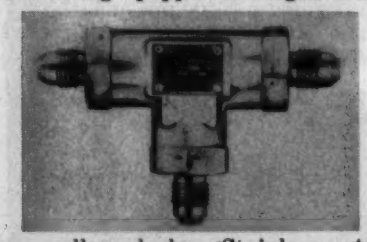
FURTHER INFORMATION AVAILABLE
CONSULT WITH US ON YOUR NOISE PROBLEMS

Quan-Tech LABORATORIES, BOONTON, N. J.

See us at the WESCON Booth 1029
CIRCLE 72 ON READER-SERVICE CARD

SHUTTLE VALVE

New Model SV4 light weight shuttle for hydraulic fluids or inert gases up to 3000 psig with operating temperatures of −65° to 165°F features "no-time-lag" poppet in forged aluminum alloy body. Stainless steel bodies for higher pressure ranges also available. Full information on request.—*Marotta Valve Corp., Boonton Ave., Boonton, N. J.*



CIRCLE 258 ON READER-SERVICE CARD

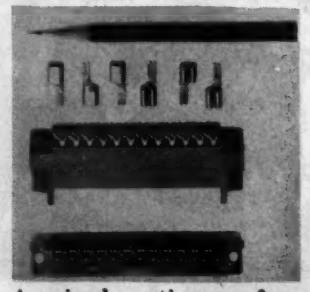
IMPULSE RELAY

New Series 670 Impulse Relay reverses its cam actuated contacts with each momentary impulse (up to 10 steps per second). Contact arrangements up to DPDT, 1500 watts noninductive; and coil voltages to 230 vac or 110 vdc are available. Applications include on/off control of lights, and motors, among others.—*Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill.*

CIRCLE 259 ON READER-SERVICE CARD

TAPER PIN CONNECTOR

New Elco Series 7009 Varitwin-Pin printed circuit connector for taper pin assembly provides each contact

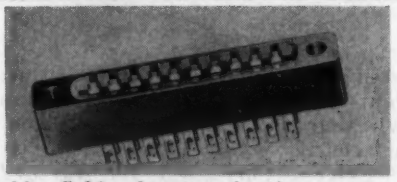


with 4 coined mating surfaces for low resistance and high contact reliability. Set in rugged glass-filled diallyl phthalate to accept Series 53 taper pins.—*Elco Corporation, M St below Erie Ave., Philadelphia 24, Pa.*

CIRCLE 260 ON READER-SERVICE CARD

PRINT-CKT CONNECTOR

New printed circuit connector has 10 dual contacts which accept 1/32" thick printed circuit board or tape

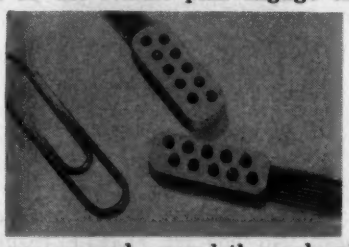


cable. Solder lug terminations accommodate #22 AWG wire.—*Electronics Div., De-Jur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.*

CIRCLE 261 ON READER-SERVICE CARD

FLAT CABLE CONNECTOR

A sub-miniature connector "138", is designed for use with Cicoil submin super-flex stranded wire harnesses. The male pins are recessed and as the female pins engage they



are compressed around the male pins to form a secure electrical and mechanical self-locking connection. Complete data on wide range of insulations and sizes is available.—*Cicoil Corp., 13833 Saticoy St., Van Nuys, Calif.*

CIRCLE 262 ON READER-SERVICE CARD

Versatile Servo Analyzer

Phase, transient and amplitude responses of all ac and dc servo systems, receivers, amplifiers, computer circuits and transmission line components are determined by the new Polarad Model SV-1 Servo Analyzer. (Fig. 1) These analytic measurements are accomplished in this single unit which generates an output signal which is applied to the system or component under test and by comparing a reference signal with the signal returned from the system or component under test.

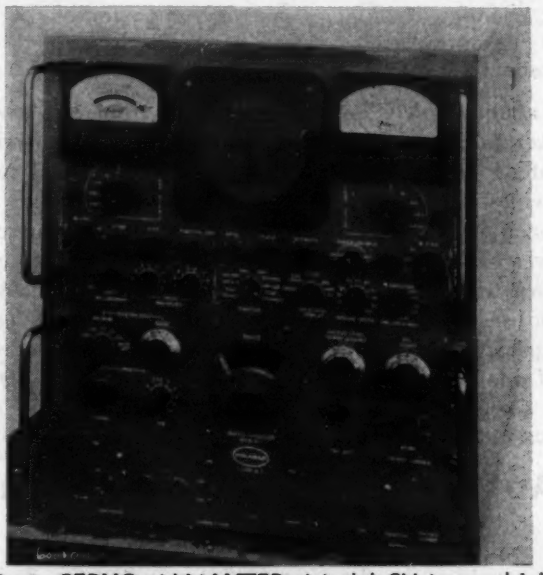


FIG. 1. SERVO ANALYZER, Model SV-1, combining a multiple precision signal generator and oscilloscope, measures phase and amplitude responses on all types servo systems and components.

Phase response may be measured by the use of bowtie, Lissajous, or linear sweep patterns as provided by the servo analyzer (Fig. 2).

For testing AC servo systems, an external carrier signal is modulated by the servo analyzer to form a suppressed carrier envelope, which is then applied to the input of the servo system. For testing DC servos, the analyzer generates a low-frequency sine wave which is fed to the servo system instead of the modulated carrier mentioned above.

In all cases, the return signal is applied to the vertical plates of the internal oscilloscope of the Model SV-1. Simultaneously, one of five internally generated signals is applied to the horizontal plates of the oscilloscope to provide a bowtie, Lissajous, or sweep pattern on the face of the cathode-ray tube. The resulting response pattern is adjusted until 0° phase shift is viewed on the oscilloscope screen. Then, readings may

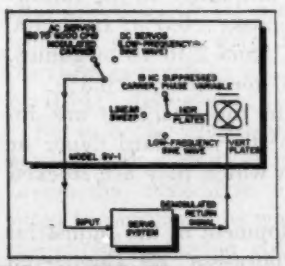


FIG. 2. PHASE response measurement.

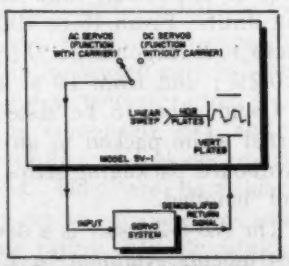


FIG. 3. TRANSIENT response measurement.

be obtained in degrees directly from the calibrated dial.

Transient response is observed (Fig. 3) by connecting the system under test to the Function Output jack and viewing the return signal on the oscilloscope while square wave, triangular wave, ramp, or impulse functions are generated. These functions may be selected with carrier (for testing AC servos) or without carrier (for testing DC servos).

Amplitude response is measured by calibrating the oscilloscope in the conventional manner and measuring the amplitude of the return signal on the oscilloscope. (*From 4-page bulletin, Model SV-1 Servo Analyzer.—Polarad Electronics Corp.*, 43-20 *34th St., Long Island City* 1, *N. Y.*)

FOR THIS LITERATURE CIRCLE 263 ON READER-SERVICE CARD

Waveguide Seals

Tight sealing of waveguides requires gas-tight and RF-tight gasketing at each waveguide flange. Parker Waveguide Seals for WR- and X-band guides, mate two standard waveguide flanges with electrical continuity assured by contact of flange surfaces with knurled areas inside the rubber gasket seal. (Fig. 1). Hermetic seal is provided by double-ridged gasket

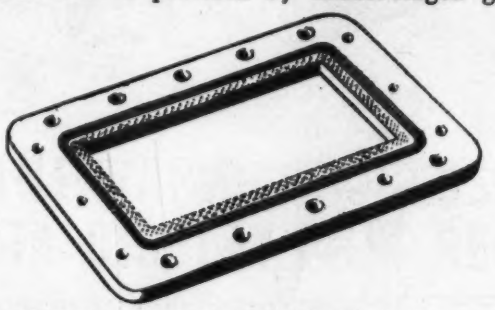


FIG. 1. STANDARD WAVEGUIDE SEAL shows knurled area which makes electrical contact with flat waveguide flange face, also double rubber gasket which hermetically seals against loss of pressure, entrance of moisture.

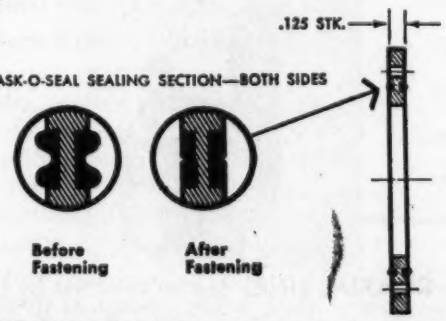


FIG. 2. CROSS SECTION and Detail of sealing action of rubber Gask-O-Seal gasket.

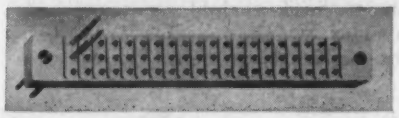
which deforms under pressure to fill the channel in the gasket. No channel in waveguide flange is needed (Fig. 2).

Other sealing problems are solved by Stat-O-Seals (for sealing around studs and bolts), Gask-O-Seals (for hermetic sealing of connectors) and by Strip-O-Seal (a "do-it-yourself" sealing strip which can be fitted around irregular openings where small quantities make a large special one-piece Gask-O-Seal uneconomical. (*From 9-page Catalog Folder No.* 5801.—*Parker Seal Co., Culver City, Calif.*)

FOR THIS LITERATURE CIRCLE 264 ON READER-SERVICE CARD

TAPER-PIN TERMINALS

New Series 100-53 solderless terminal-block receptacles are precision reamed to accommodate standard

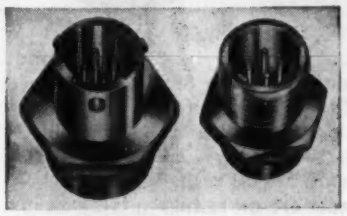


"AMP 53" solderless taper pin wiring terminals with high mechanical bond and low contact resistance.—*Precision Connectors Inc., P.O. Box* 96, *Mineola, L. I., N. Y.*

CIRCLE 265 ON READER-SERVICE CARD

ORDNANCE CONNECTORS

New glass-to-metal pyrotechnic connector for missile and space vehicles seal positively and hermetically tight to 10^{-9} cc/sec helium, mate with

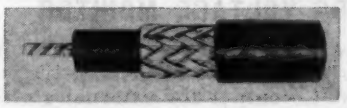


most standard makes of electrical connectors and are made on bridgewire end to suit requirements of explosive package. Write on Company letterhead for literature and samples. —*Electronic Seals, Inc.* 13766 *Saticoy St., Van Nuys, Calif.*

CIRCLE 266 ON READER-SERVICE CARD

CUSTOM MULTICONDUCTOR CABLES

New process for manufacturing neoprene and polyvinylchloride jackets for multiconductor cables places



no restrictions on the minimum length of the run or on the number of cable connectors as long as the O. D. does not exceed 4".—*Alpha Wire Corp.*, 200 *Varick St., New York* 14, *N. Y.*

CIRCLE 267 ON READER-SERVICE CARD

ULTRA-THIN WIRE

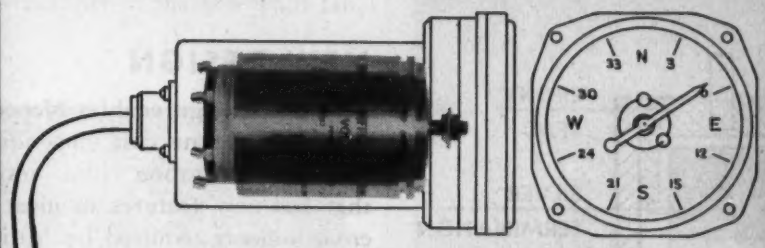
New series of silver plated copper conductors from AWG 28 (7/36 stranding) down to AWG36 (7/44 stranding), and in solid silver-plated copper conductors from AWG 20 to AWG 36 are available with ultra-thin Teflon insulation (1 to 6 mils thick) rated for 300 v at temperatures from −90° to 250°C.—*Tensolite Insulated Wire Co., Inc.*, 1000 *N. Division St., Peekskill, N. Y.*

CIRCLE 268 ON READER-SERVICE CARD

THE Bendix CORPORATION

Montrose DIVISION

60 or 400 CYCLE 115 VOLT SYNCHRO INDICATORS



3 or 5 INCH DIALS

NOW AVAILABLE a Military type 23TR6A Synchro Receiver conveniently packaged for immediate installation in ground support equipment consoles or shipboard installations. Your choice of dial presentations which will accurately display the angular or position information received from a remote synchro transmitter. The indicator is ready for front or rear panel mounting. The connector provided on the indicator mates with an AN3106-14S-2S plug. Power requirements are 5 watts at 115 volts. The indicator is pressure sealed by "O" rings for protection against sand, dust, and moisture. The synchro contained in this indicator meets detail requirements of MIL-S-20708. The general specifications of the indicator are as follows:

- weight—2¾ lbs.
- temperature range —55° C. to +85° C.
- accuracy—¼ of 1% of full scale (360°)

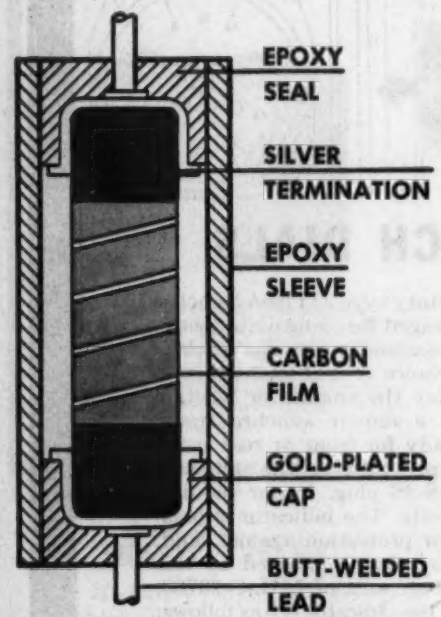
West Coast Sales and Service Office—117 East Providencia Avenue, Burbank, California
Canadian Sales Office—Aviation Electric Limited, 200 Laurentien Blvd., Montreal, Quebec
Export Sales and Service—Bendix International, 205 East 42nd St., New York 17, New York

Montrose Division
SOUTH MONTROSE, PA.

THE Bendix CORPORATION

CIRCLE 73 ON READER-SERVICE CARD

NEW MEDIUM PRICED LIGHT WEIGHT CARBON FILM RESISTORS



NEW DESIGN

This new design enables Mepco to offer a moderate cost, dependable, lightweight carbon film resistor that has new features to meet the environments required by Military Specification MIL-R-10509C Characteristic B.

FEATURES

Moisture which might be absorbed during extended storage periods under high humidity conditions, cannot be transmitted to the carbon film due to the dry air space between the epoxy tube and the resistive element.

PHYSICAL AND ELECTRICAL CHARACTERISTICS

TYPE		RATING			VOLTAGE RESISTANCE			SIZE			
Mepco	MIL-R 10509C	Watts Mepco @ 125°C	Watts Mepco @ 70°C	Watts MIL @ 70°C	Max. Cont. VDC	Min. Ohms	Max. Meg. Ohms	Length	Tol.	Dia.	Tol.
EP-012	RN60B	0.125	0.25	0.125	250	5	1	.4335	±.0035	.156	±.010
EP-025	RN65B	0.25	0.50	0.25	300	10	2	.640	±.015	.240	±.010
EP-050	RN70B	0.50	1.00	0.50	350	10	5	.830	±.015	.240	±.010
EP-100	RN75B	1.00	1.00	1.00	500	10	10	1.093	±.020	.395	±.010
EP-200	RN80B	2.00	2.00	2.00	750	50	20	2.230	±.020	.395	±.010

EP SERIES

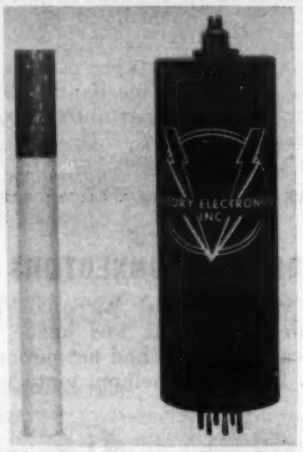
WESCON Show Booth 645

MEPCO INC. MORRISTOWN, N. J.

CIRCLE 74 ON READER-SERVICE CARD

KILOVOLT MICRO PACK

Geiger tubes, IR detectors and other high-voltage, low-current devices gain added portability with new transistorized variable voltage dc-dc converter which operates from penlight or mercury cell. Models now



available use 1.5 to 6.0 v dc inputs, give outputs from 800 to 20,000 v dc. Highly shock-resistant, full characteristics and data are available on request.—*Victory Electronics, Inc., 50 Bond St., Westbury, L. I., N. Y.*

CIRCLE 273 ON READER-SERVICE CARD

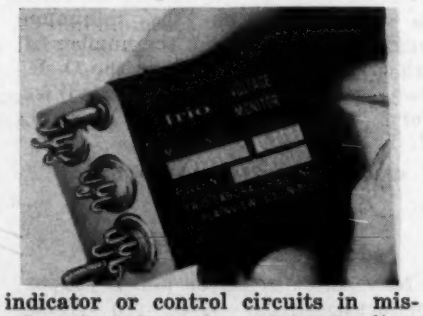
SILICON DC POWER

New high-power, magnetic amplifier regulated dc power supplies furnishing from 100 to 1500 amperes, 14 to 36 volts, utilize 60 cps 3-phase 208. 230/460 v ± 10% input. Output current regulation to 0.01% can be supplied if required. Output voltage regulation no-load to full load ± 0.1% for 100 to 500 amp units, ± 0.25% for 1000 to 1500 amp units.—*Sprague Engineering Corp., 19300 So., Vermont Ave., Gardena, Calif.*

CIRCLE 274 ON READER-SERVICE CARD

DC VOLTAGE MONITOR

New transistorized precision voltage sensing device Model 203-1 gives Go/No-Go output for external alarm,



indicator or control circuits in missile, aircraft and support applications. "Inhibit" terminal prevents operation of the monitor at selected times without disrupting other connections. "Latch" terminal, when connected to the "Inhibit" terminal will lock normally open contacts in closed position when the input exceeds the pull-in voltage.—*Trio Laboratories, Inc., Plainview, L. I., N. Y.*

CIRCLE 275 ON READER-SERVICE CARD

Transmit-Receive Relays

Switching of RF by remote control can be accomplished by one of four DPDT Advance Antenna relays (Fig. 1) ranging from the midget AM series to the very heavy AT series, with the AL latching series available for applications where positive contact in either mode, with only momentary flow of actuating current, is desired. These antenna switches are designed for use with open-wire antenna circuits where the same antenna is switched from "transmitter" to "receiver". Coils for dc from 6 to 110 volts and requiring from 1.5 watts for the AM type to 3 watts for the AT type, or for ac from 6 to 220 volts and requiring from 3 to 10 volt amperes are standard. Insulation ratings at 500 v rms are standard for all types with 1000 v available on special order for the very heavy switches of the AT series.

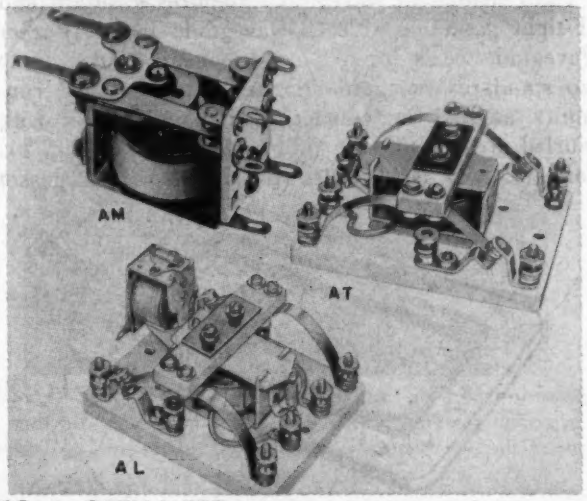


FIG. 1. OPEN WIRE antenna circuits can be remotely switched by Midget (AM), Latching (AL) and Very Heavy Duty (AT) relays. Advance Type AH (Small) antenna relay is not illustrated.

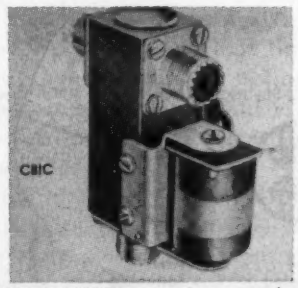
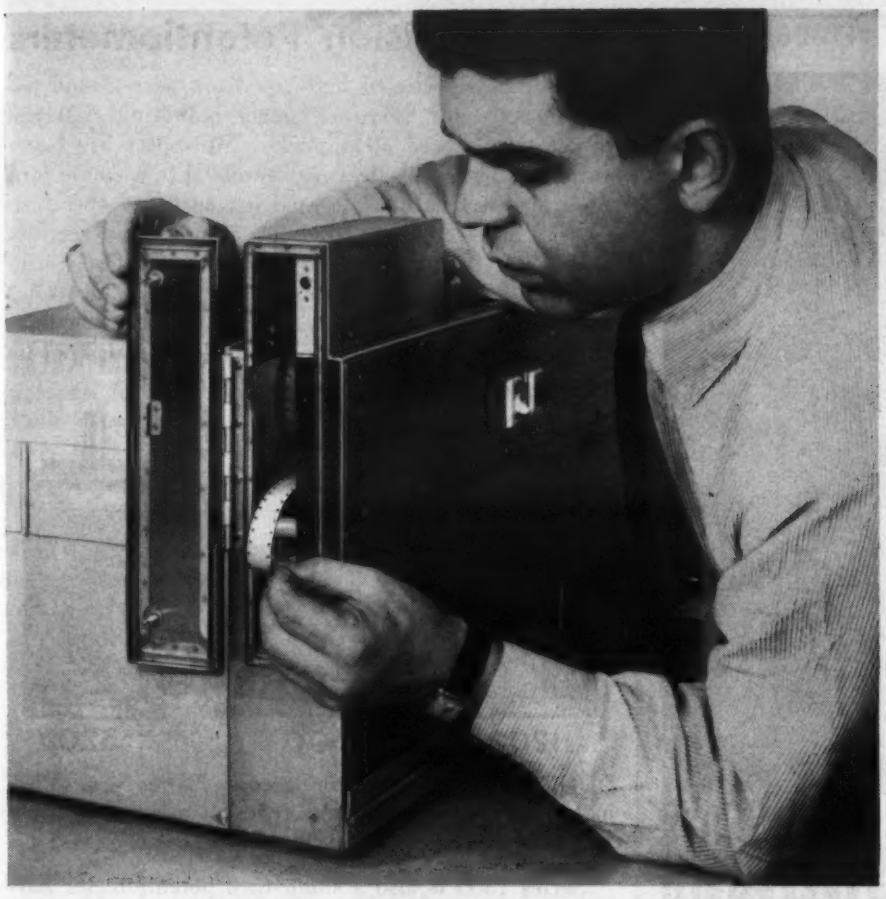


FIG. 2. COAXIAL LINES can be switched by CB type Relay.

Coaxial styles, however, are more often required in modern VHF radio installations and equipment. Typical of the Advance relays available for such service is the CB series (Fig. 2), which features internal SPDT contacts to connect or disconnect the inner conductor of standard 52-ohm cable. Operation on lines other than 52 ohms can also be accomplished, however. These contacts are of heavy quarter-inch fine silver and are supported directly from the cable connectors, giving a very low SWR up to 300 mc. (*From 69-page catalog of Advance Relays for aircraft, missile and industrial use.—Electronics Div., Elgin National Watch Co., 2435 No. Naomi St., Burbank, Calif.*

FOR THIS LITERATURE CIRCLE 276 ON READER-SERVICE CARD



MINI-RAPID PROCESSOR DEVELOPS DATA DISPLAY FILM RECORDS—FAST!

See your data display film records in minutes. Fairchild Mini-Rapid Film Processors give you automatic delivery of negatives — developed, fixed, washed, dried—commercial quality.

16mm films up to 6 f.p.m.

35mm films up to 4 f.p.m.

Oscillograms, digital or analog display, radar, meters, gauges, controls — any information display that you record on 35 or 16mm film can be read back just a few minutes after your film is inserted into the Mini-Rapid.

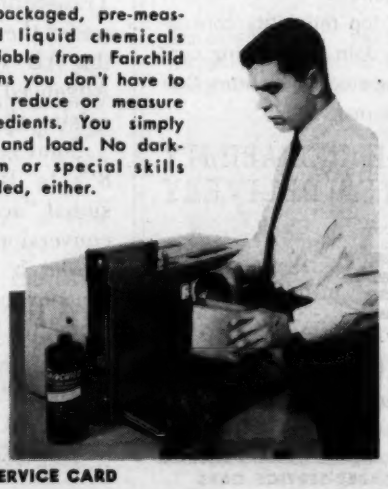
Operation? Easy. Insert a few inches of film into the loading compartment, drop in spool, close door. Automatic transport takes over and does the rest.

Write for illustrated specifications and prices to Industrial Products Division, Dept. IPD-4, Fairchild Camera and Instrument Corp., 580 Midland Ave., Yonkers, N. Y.

MINI-RAPID FEATURES

- capacity up to 400 feet
- table top compactness
- dual thermostat control
- completely automatic
- leaderless daylight loading
- self-threading film transport

Pre-packaged, pre-measured liquid chemicals available from Fairchild means you don't have to add, reduce or measure ingredients. You simply mix and load. No darkroom or special skills needed, either.



INDUSTRIAL PRODUCTS DIVISION
FAIRCHILD
CAMERA AND INSTRUMENT CORPORATION

CIRCLE 75 ON READER-SERVICE CARD

Thinner Fans

Provision of adequate or additional ventilation is frequently a requirement that comes to light only in the final stages of equipment design, or in attempting to adapt a stock equipment to unusual environmental conditions. The new Kooltronic Thin fan, (Fig. 1) engineered to provide 165 CFM with an overall depth of 2⅞" and available in larger sizes up to 750 CFM in an overall depth of 4⅜", may be utilized without interfering with established circuitry or physical arrangements of components in applications. Filter holders, grilles and other accessories are available to increase the inherent versatility of the new Thin fan.

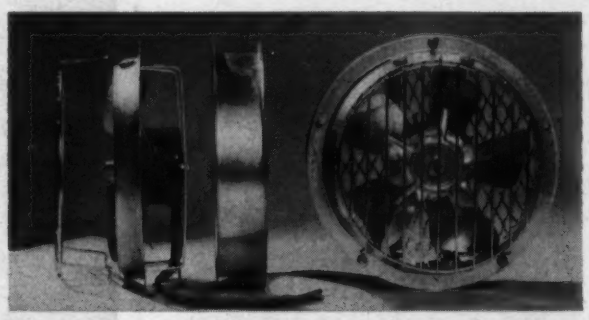


FIG. 1. **"THIN FAN"** design provides 165 CFM air with overall depth of only 2⅞".

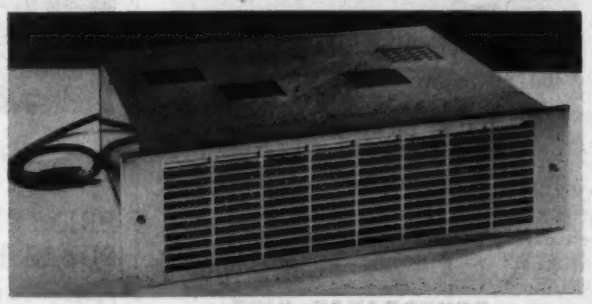


FIG. 2. **RACK-MOUNTING** blower and filter combination package comes in three models. Model KP525 provides 350 CFM air with only 5¼" of panel height.

A second solution of Kooltronic for rack-mounted gear is the rack-mounting package of blower and filter available in three sizes. The KP525 (Fig. 2) provides 350 CFM in only 4¼" of panel height, the KP700 provides 550 CFM with only a 7" of panel height, while the KP875 furnishes 500 CFM in a panel height of 8¾" but with a depth of only 4¾" for providing a maximum of usable space in the rear of the cabinet.

Rubber mountings, quiet fan blade design and ball bearings silence already quiet-running powerful 115 v 60 cps capacitor type motor. 230 v ac or 28 v dc motors, sleeve bearings and shaded power motors are also available in some designs. Complete descriptions and data are contained in a new 6-page brochure from the manufacturer, *Kooltronic Fan Co., Quaker Bridge Rd. at Village Rd. West, Princeton, N. J.*

FOR THIS LITERATURE CIRCLE 277 ON READER-SERVICE CARD

CIRCLE 76 ON READER-SERVICE CARD

FIRST AGAIN!

New Babcock 10 amp Magnetic Latching Relay

New subminiature Model BR-9, meets Mil R 5757C, 25018, with vibration to 30g @10 – 2000 cps, 50g shock @11 millisec over –65°C to 125°C range. Bulletin BR-594.

BABCOCK BR-1S RELAY

Miniature, hermetically sealed BR-1SZ requires only 5 mw power, features very critical pull-in to drop-out ratios, 100,000 op. min. and –65°C to 125°C ranges. Meets Mil R 5757C, 6106C, 25018. Bulletin BR-593.

BABCOCK RELAYS

BABCOCK BR-7 RELAY

Subminiature 10 amp, DPDT relay with 0.2" grid spaced header accepts 30g vibration @10 – 2000 cps, 50g shock @11 millisec. over range of –65°C to 125°C. 100,000 op. min. @+125°C. Meets Mil R 5757C, 25018. Bulletin BR-592.

BABCOCK BR-8 RELAY

Subminiature A. C. or D. C. crystal can relay, 250,000 op. min. @+25°C. Vibration, 30g, 40 – 2000 cps. at –65°C to +125°C. Available with adjustments for repeatability over millions of operations. Meets Mil R 5757C, 25018. Bulletin BR-591.

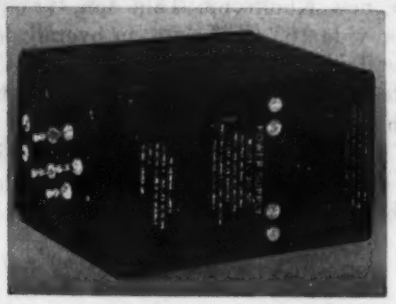
BABCOCK RELAYS, INC.

1640 Monrovia Ave., Costa Mesa, Calif.

CIRCLE 90 ON READER-SERVICE CARD

COMPACT DC POWER

New 20-Series of compact dc power supplies features an external potentiometer for output voltage adjustment, a removable external cover for easy inspection and maintenance, and

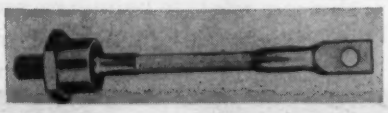


either solder terminal or octal plug input and output connection. Outputs from 5 to 50 v dc and 225 to 750 ma are available from 105-125 vac, 60-400 cps inputs.—*Dressen-Barnes Corp., 250 North Vinedo Ave., Pasadena, Calif.*

CIRCLE 281 ON READER-SERVICE CARD

SILICON POWER RECTIFIER

New Style 40 double-diffused, hermetically sealed power rectifier is

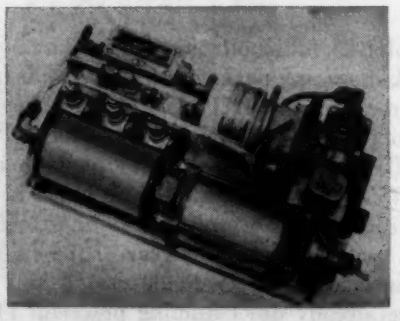


available in PIV values from 100 to 400 v. Typical forward dynamic resistance of only 0.0015 ohms provides a peak forward voltage of only 1.2 v max at 100 amp.—*Syntron Company, 622 Lexington, Ave., Homer City, Pa.*

CIRCLE 282 ON READER-SERVICE CARD

DEHYDRATOR UNIT

New combination Pressurization and Dehydrator Unit features automatic self-reactivation eliminating



desiccant replacement. Meets MIL E-5400 and MIL M-7969A specs, and can be used on a variety of specific airborne, shipboard, undersea, and ground support equipment.—*Great Lakes Mfg. Corp., 4223 Monticello Blvd., Cleveland 21, Ohio.*

CIRCLE 283 ON READER-SERVICE CARD

CUSTOM CIRCUIT PACKAGING

...To mil Specs

PRINTED CIRCUITS
SUBASSEMBLIES

Pace Circuit's specialized experience and advanced facilities provide an unusual flexibility in printed circuit and subassembly design and manufacture . . . from mock ups to full production runs. Miniaturized and encapsulated designs a specialty. New expanded plant and processing equipment plus unique quality control techniques assure top reliability consistently . . . on time. Join our growing customer list of leading electronics firms. Call or write for full information.

HIGH RELIABILITY
FASTER DELIVERY

Sales representatives in principal cities.

Ploneer 1-3360

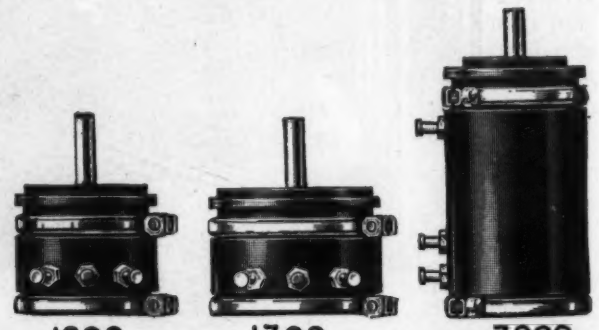
PACE CIRCUITS CORP.

393 Sagamore Avenue, Mineola, New York

CIRCLE 91 ON READER-SERVICE CARD

High-Precision Potentiometers

Three new series of high precision wire-wound potentiometers for servo or panel mounting designed to meet or exceed all applicable Mil-Specs are being furnished with taps electrically welded to a single turn of wire and accurately located per customer specifications. Linear characteristics are standard but certain non-linear functions are available on order. Series 1200, a single-turn 7/8" diameter type is rated at 1.2 watts at 60°C derating to zero at 125°C. Nine taps, exclusive of end terminals can be added in desired locations.



DUNCAN Precision Potentiometer Series are shown in Military Servo Mounting styles.

Series 1300 is also a single-turn potentiometer having a body diameter of 1-1/16", a power rating of 2 watts, and improved resolution and linearity made possible by the slightly larger diameter. Nine taps can be provided to customer's specification.

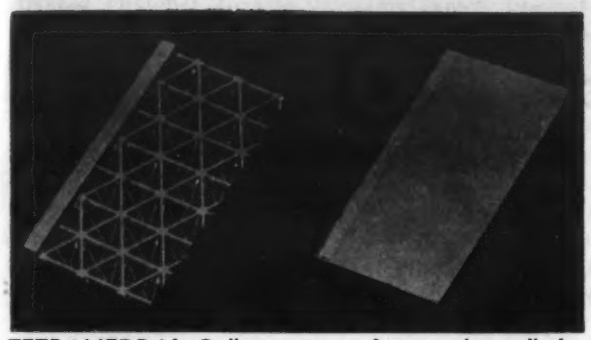
The Series 3200 comprises a family of miniature multi-turn precision potentiometers, 7/8" in diameter, in turn sizes of 3-, 5- and 10-turns. Accurately positioned, electrically welded taps up to a total of 46 for the ten-turn size, may be added on special order. (*From manufacturer's specification sheets, Duncan Series* 1200, 1300 *and* 3200 *Potentiometers, Duncan Electronics, Inc.,* 1305 *Wakeham Ave., Santa Ana, Calif.*)

FOR THIS LITERATURE CIRCLE 287 ON READER-SERVICE CARD

Solar Cell Improvements

Research studies carried out by scientists at the Transitron Electronic Corporation, Wakefield, Mass., under the sponsorship of the U. S. Army Signal Corps, the Air Force Cambridge Research Center and the Advanced Research Projects Agency are credited with raising the efficiency of silicon solar cells to 15%.

Solar cells produced in 1959 consistently gave from 8% to 10% conversion efficiency except for occasional "accidents" which gave an unusually high 14% conversion to electricity of all solar energy received. Research has now raised the overall conversion efficiency of the units by design of the cell structure from the flat surface previously used to a new tetrahedral structure (See Figure), and by development of new silicon surfaces and adjustable optical coatings. The effect of the tetrahedral structure is to increase the surface area and simultaneously to lower



TETRAHEDRAL Cell structure of new solar cell developed for powering satellites and other applications is compared with typical flat shape of earlier solar cells (right).

the series resistance of the cell.

The new cells, used with light concentrators, are said to be able to increase the output up to 10 times that previously possible, making a 5-cell array of 1 watt output practicable.

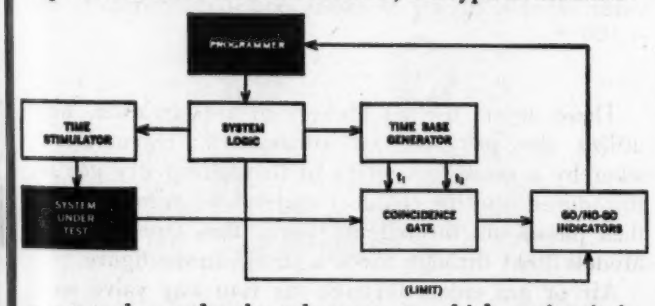
Progress to date toward the theoretically ideal Solar Converter is shown in the table below:

	1959	1960	Ideal
Conversion Efficiency	10%	15%	22%
Output Voltage to Load	0.40 v	0.45 v	0.50 v
Internal Circuit Losses	10%	2%	None
Optical Collection Losses	10%	2%	None
Carrier Collection Losses	40%	20%	None

FOR MORE INFORMATION CIRCLE 288 ON READER-SERVICE CARD

Universal Control and Test Equipment

Basically, the UACTE consists of electrical measuring devices and voltage reference sources that are capable of being interconnected in order to evaluate functional parameters of a known given circuit. Eighty bits of binary information can be programmed on tape to establish interconnections, the type of measure-



ment to be made, the tolerances to which a circuit is to be evaluated, and control information.

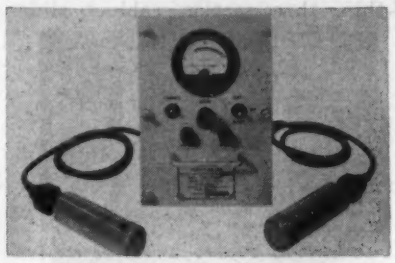
The crystal controlled clock referred to as the timing generator initiates a gate after a programmed period. This programming capability allows a time measurement and comparison to be made at some preselected period from 0.1 to 100 seconds.

The UACTE has the capacity to perform a vast number of functions. Space and logic have been provided to accommodate particular needs of industry. Direct digital output is available to operate a commercial type printer, if a record of the test results is desired . . . (*From new 16-page Technical Bulletin 829903, Pacific Automation Products, Inc., 1000 Air Way, Glendale, Calif.*)

FOR THIS LITERATURE CIRCLE 289 ON READER-SERVICE CARD

CONDUCTIVITY METER

New direct-reading meter Type RA-1 measures conductivity of demineralized water. All components



meet applicable Mil-Specs and overall unit meets applicable shock and vibration requirements of Military specifications.—*Industrial Instruments, Inc., 89 Commerce Road., Cedar Grove, N. Y.*

CIRCLE 290 ON READER-SERVICE CARD

POWER INVERTER

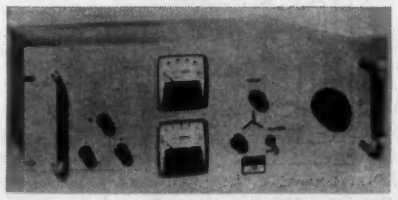
New Model 828 Power Oscillator, designed for driving high speed motors of the 100,000 rpm type and to furnish demodulation signals to am-

plifier circuits. Meets applicable requirements of MIL-E-5272B. Output is 5 kc ±5% at ±15 volts (6VA), harmonic distortion less than 8%.—*Metrolog Corporation, 169 N. Halstead St., Pasadena, Calif.*

CIRCLE 291 ON READER-SERVICE CARD

DC POWER SUPPLY

New "60" Silver Trygon Series of transistorized, rack-mounted power supplies furnish a 0-60 v variable dc output at 0-2.5 amps and 0-5 amps



with 0.01% line and load regulation and less than 1 mv ripple. All units are available with remote programming.—*Trygon Electronics, Inc., 111 Pleasant Ave., Roosevelt, L. I., N. Y.*

CIRCLE 292 ON READER-SERVICE CARD

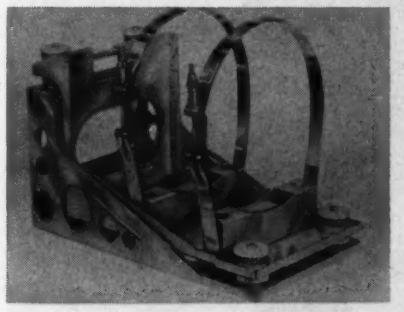
MODULAR TEST CHAMBER

New Modular Test Chambers providing precise control within ½°F over temperatures from —100° to 750°F, and temperature shock rates variable from 5° to 200°F change per minute, will be introduced by Statham at WESCON. Basic 8 cu-ft module accommodates standard relay-rack chassis, expands modularly in height, width and depth. Automatic control using solid-state plug-in console is optional. Uses include electronic lab tests, plastics conditioning, quality and life tests, and production line operations.—*Statham Development Corp., 12401 W. Olympic Blvd., Los Angeles 64, Calif.*

CIRCLE 293 ON READER-SERVICE CARD

MET-L-DAMP MOUNTS

New MET-L-DAMP, (structural damping) employing a dynamic interaction between viscoelastic layers situated between metal structural members (in this case aluminum), and MET-L-FLEX stainless steel wire



cushioning elements are used in the Model 2678-1 (illustrated). This center-of-gravity type mounting is designed to protect a frequency converter installed in the B-52G bomber, and meets the vibration and shock requirements as specified in MIL-E-5272A.—*Robinson Technical Products, Inc., Teterboro Air Terminal, Teterboro, N. J.*

CIRCLE 294 ON READER-SERVICE CARD

ECONOMICAL TO OWN
EFFICIENT TO USE

PBR SCOPE DOLLY

$59.95 F.O.B. Phila., Pa.

For laboratory, for research; use with any standard scope. Adjustable from 9" to 12¾" wide, 16½" to 22½" long.
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- Protective rubber gasket for scope
- 5" ball-bearing, rubber-tired casters
- Storage area for preamplifiers, tool shelf, etc.
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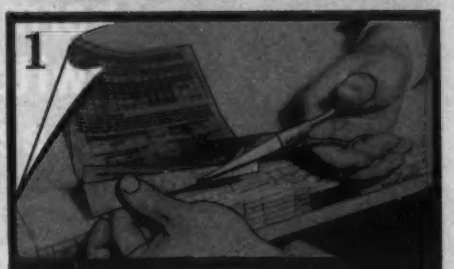
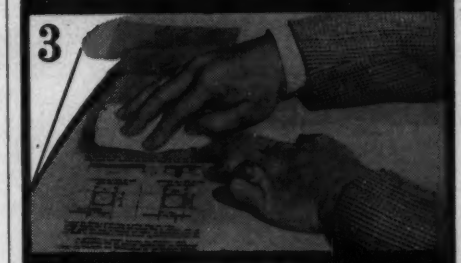


PEEL
the STANPAT from its backing.

PLACE
the STANPAT into position on the tracing.



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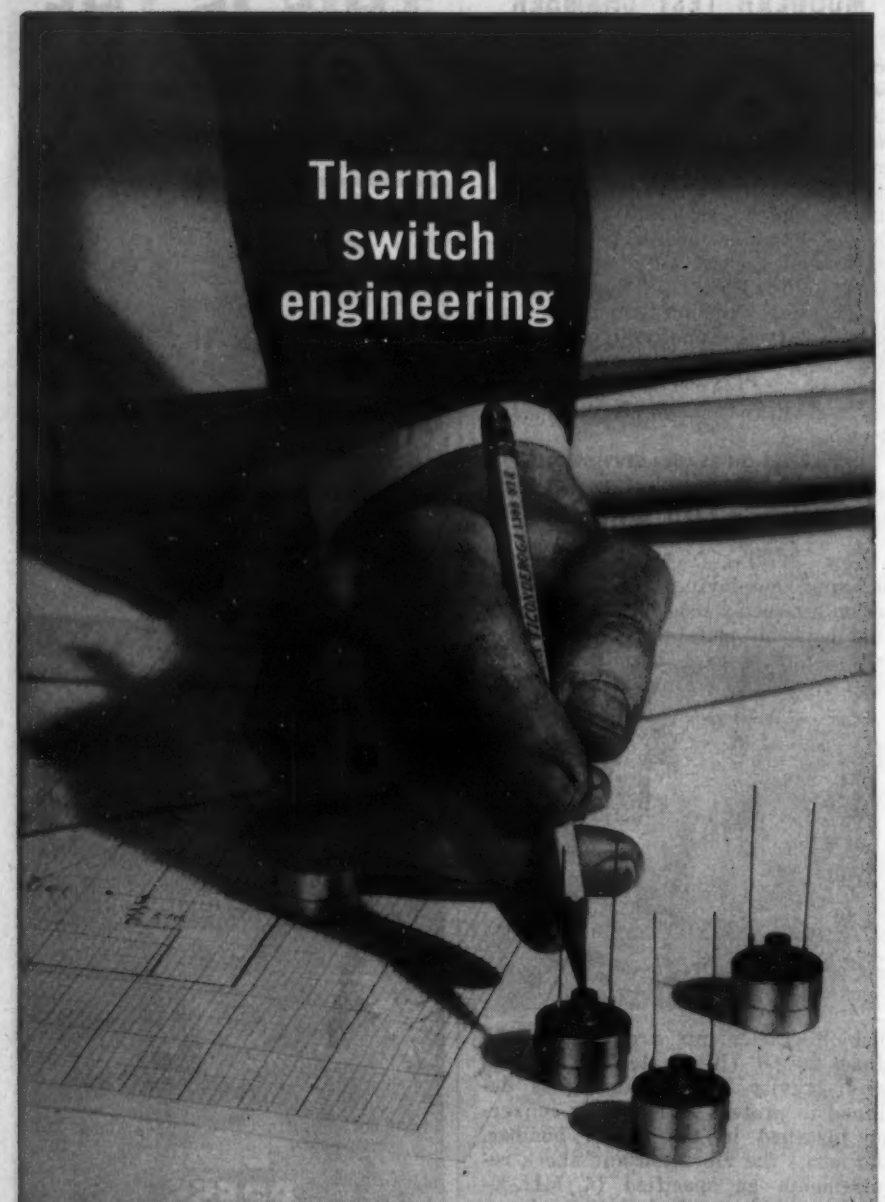
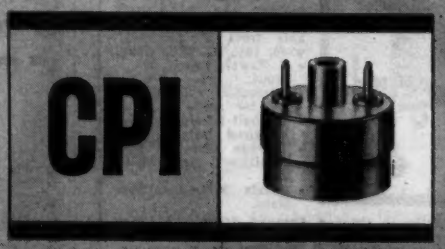


ANOTHER "CRITICAL" CONTROL SWITCH FROM CPI RESEARCH

If you are concerned with measurement of surface temperatures in aircraft and airborne electronic equipment in confined spaces, this may be a thermal switch you could use. We designed and manufactured it to meet exacting specifications of a prominent aircraft manufacturer.

Chances are your needs may require modifications or even a completely new switch. We have always realized that there are few "critical" control switches that can be all things to all people. That's why we have the research and development engineers who can and do tackle specific problems of thermal control. Can we help you solve yours?

This new hermetically sealed, bi-metal, single or 2-wire switch has calibration range of -20F to 600F; safe momentary overshoot to 800F; available with various type mountings. When inquiring, mention "button" switch.



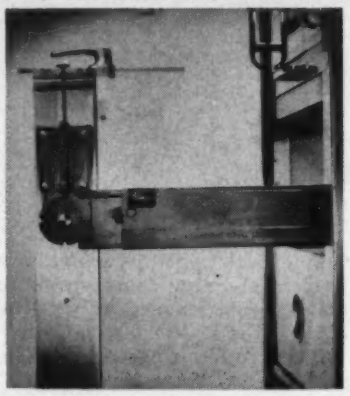
CONTROL PRODUCTS, INC.

274 Ridgedale Avenue, Hanover, N. J.

CIRCLE 79 ON READER-SERVICE CARD

UTILITY SLIDE

New cabinet slide Type C-230 with a load capacity of 100 lbs has been added to the Chassis-Trak line of pencil-thin, three-section cabinet slides.

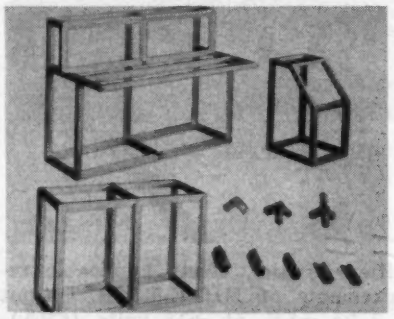


All are available in tilting, non-tilting and tilt-detent designs. A pair of C-230 fully-extendable slides takes up only 0.620" of usable cabinet space, permitting their use with oversize chassis.—*Chassis-Trak, Inc., 525 S. Webster Ave., Indianapolis 19, Ind.*

CIRCLE 295 ON READER-SERVICE CARD

ALUMINUM ENCLOSURES

Standard Modular Aluminum Instrument enclosures from 7" to 20' in width, height or depth can be developed using new aluminum heat-treated

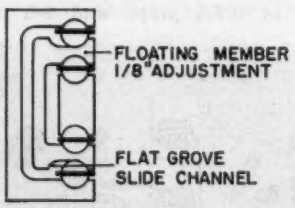


extrusions and castings. Built-in locking devices eliminate tools, bolts, nuts, etc.—*Amco Engineering Co., 7333 W. Ainslee St., Chicago, Ill.*

CIRCLE 296 ON READER-SERVICE CARD

"SELF-ALIGNING" SLIDE

New "Flat Groove" principle automatically adjusts to fit misaligned chassis and cabinets, producing same



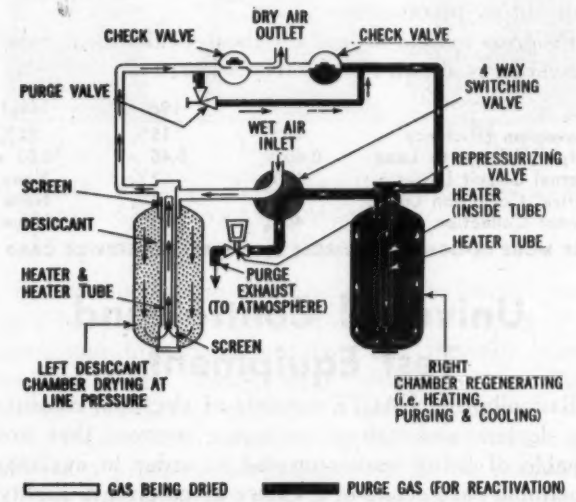
efficient slide action found in perfectly aligned slides. Load rating on Self-Aligning slides are the same as for regular Grant Slides.—*Grant Pulley & Hdwe. Corp., High St., West Nyack, N. Y.*

CIRCLE 297 ON READER-SERVICE CARD

Automatic Regeneration of Desiccant Maintains Reliable Dry-Gas Systems

Type A Heat Reactivated Dryers for air or gas automatically operate to provide a dependable source of gas with dewpoints down to —100°F. Semi-automatic and manual units are also available on special order.

Currently used in military, industrial and scientific operations, many of these units have been in service for periods of over 10 years of proven economy, dependability and performance. Uses include drying of instrument air, atmospheric furnace purging, electronic transmission line purging, drybox assembly purging and food and drug processing.



AUTOMATIC REGENERATION of desiccant provides reliable drying of gases down to dewpoints of —100°F.

These dryers use no blowers or refrigeration, but utilize the principle of atmospheric regeneration whereby a small percentage of the effluent dry gas is introduced into the chamber undergoing regeneration, then passes out through the purge line. Operation of Models 300A through 875A is shown in the figure.

Air or gas enters through the four-way valve and passes into the left-hand chamber. It here passes through the desiccant bed which absorbs the moisture. The dried gas then goes through the heater tube, through the open check valve, and out into the system. A small percentage of the dried gas passes through the purge valve to the chamber undergoing reactivation (right-hand) which has been dropped to atmospheric pressure.

The purge air is preheated as it passes over the electric heaters, and carries off the moisture in the right-hand desiccant bed out through the purge exhaust valve.

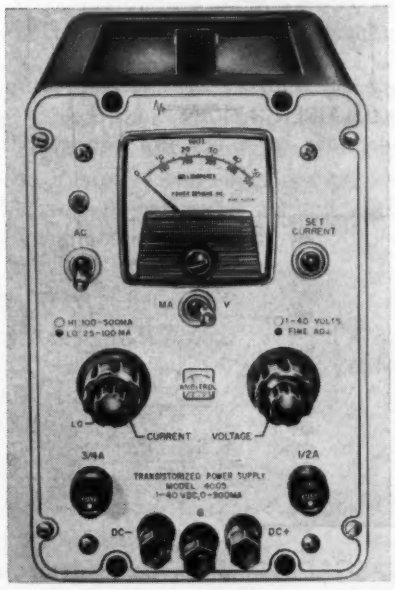
At the end of the heating cycle, the heater is de-energized and the right-hand chamber cools. Before the end of the cooling period, the purge exhaust valve closes, permitting a build-up of pressure in the re-

activated chamber to line pressure, which prevents downstream surges and dryer bed movement during switchover. At the end of the cycle, the switching valve directs atmospheric air or wet gas into the regenerated right chamber, opens the purge exhaust valve, and starts reactivation of the left chamber.—(*From 4-page Bulletin A-309, Type A Heat-Reactivated Desiccant Dryers, Trinity Equipment Corporation, Cortland, N. Y.*)

FOR THIS LITERATURE CIRCLE 298 ON READER-SERVICE CARD

Four-Way Versatile Power Supply

The Model 4005, first of a new power supply development family by Power Designs Inc., 1700 Shames Drive, Westbury, N. Y., can operate in four distinct modes, as: (1) a constant voltage source, (2) a constant current source, (3) as a constant voltage source with automatic current limiting, or (4) a constant current source with automatic voltage limiting. The dual regulator system, trademarked "Ambitrol," provides continuous control of voltage or current with pre-adjustable, transient free crossover to either mode of operation.



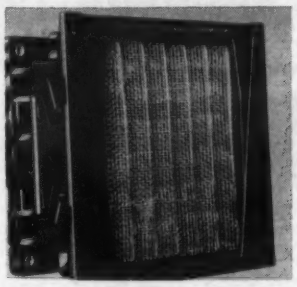
Model 4405 (see Figure) covers the 1-40 v dc voltage range with less than 500 microvolts ripple, and the 0-500 ma current range with less than 25 microamperes ripple. Dual concentric controls for both coarse and fine adjustments of current and voltage are provided. Remote programming of voltage control and the Heatran® circuit for electronic control of power transistor dissipation are also featured.

Complete transistorization permits the consolidation of the Model 4005 into a compact 5¾" x 8⅝" x 11¾", and panel adapters are also available for rack mounting. It operates from 105-125 v, 55-440 cps single phase line and either its positive or negative output terminal may be grounded.

FOR MORE INFORMATION CIRCLE 299 ON READER-SERVICE CARD

FILTER FAN

New Muffin Fan combined with filter box matched to the fan provides 75 cfm of filtered air with a clean filter in place. Filter material

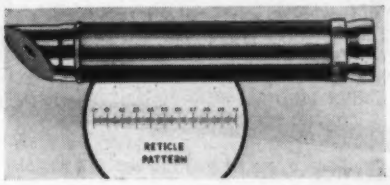


is Air-Maze Media P96A, a high velocity, viscious impingement type with efficiencies of 80% to 85% dust arrest. Muffin Fan users can obtain filter box, mounting clips and grille frame separately.—*Rotron Manufacturing Co., Woodstock, N. Y.*

CIRCLE 300 ON READER-SERVICE CARD

INSPECTION MICROSCOPE

Measuring Pocket Microscope for checking and measuring small parts under 50X magnification contains



glass etched reciticle for measuring 1/10" by 0.001" divisions.—*Edmund Scientific Co., Barrington, N. J.*

CIRCLE 301 ON READER-SERVICE CARD

SPRAY CLEANER

Model RT-R-12-5 Precision Parts Cleaner installation for cleaning General Electric's crystal case relay components and assemblies at rate of

900/hr is illustrated. Mounted parts rotate through successive high-velocity, spray cleaning operations. Ventilation system exhausts vapors.—*Cobehn, Inc., Caldwell, N. J.*

CIRCLE 302 ON READER-SERVICE CARD

EPOXY SOLVENT

New Arisolv solvent, which dissolves both cured as well as uncured, epoxy and polyester type resins, can be used to reclaim and salvage costly electronic parts should a unit fail electrical testing, also to clean equipment and handling of resins.—*Aries Laboratories, Inc., 225 Greenwich Ave., Stamford, Conn.*

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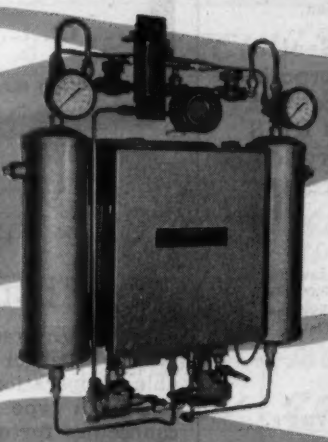
SUPER-DRY air...

the perfect dielectric for transmission media

SAVES YOU MONEY

when produced with

TRINITY EQUIPMENT



Heat-Les DRYERS

Dynamic desiccant dryers providing dewpoints below −100°F. No bothersome, expensive heaters. Completely automatic. Available in all capacity ranges. Install with compressor, or air supply of your choice...

UNITIZED DRY-AIR SYSTEMS

Completely self-contained, ready-to-operate super-dry air systems supplying continuous, dependable purging. Completely automatic, requiring only occasional routine maintenance checks. Ideal for unattended installations. Available in all capacity ranges in militarized and standard packages.

Super-dry air is your most economical, dependable dielectric for purging transmission lines and associated equipment. Trinity equipment is currently used by both the military and commercial design and manufacturing groups to assure maximum performance and greatest dependability.

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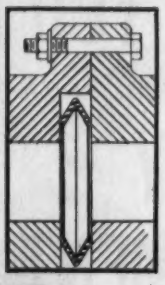
ZERO
LEAKAGE
AT 1800°F
AND ABOVE

WITH
APEX
Metallic
STATIC
SEALS



APEX SEALS can be manufactured in any size or configuration.

The Apex Metallic Seal is fully qualified for incorporation in all static applications. Surface finishes to 100 RMS may be sealed with very low flange loads. Write for Catalog 1000.

APPLICATIONS:
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DESIGNED FOR:
Low flange loads
Temperatures from −320°F to +2200°F
Normal machine finishes
High resiliency
Sealing high pressures
Sealing low pressures (vacuum)
Miniature sub-systems

also manufacturers of the
MODEL 20 SERIES
ELECTROMAGNETIC ACTUATORS
(FLAT ARMATURE TORQUE MOTORS)

PERFORMANCE CHARACTERISTICS, SERIES 20 FLAT ARMATURE TORQUE MOTORS.

MODEL	20-1	20-2	20-3	20-4
Stroke (in.)	±.006	±.007	±.008	±.015
Output Radius (in.)	.650	.393	.750	.906
Midposition Force (lb.)	2.5	5.0	8.0	13.0
Hysteresis (%)	2	2	2	2
Resonant Frequency (CPS)	940	790	580	400
Max. Power Req'd (Watts)	1.6	2.65	3.1	5.2
Weight (oz.)	2.8	5.0	9.0	19.5

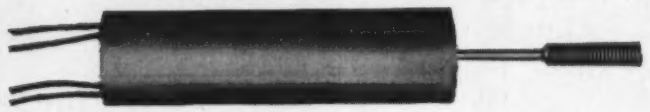
Servotronics, inc.
190 GRUNER RD. / BUFFALO 25, N.Y. / KEystone 6105

West Coast Representative
INDUSTRIAL MEASUREMENT SALES, INC.
445 N. Garey Ave., Pomona, Calif. NAtional 3-1588

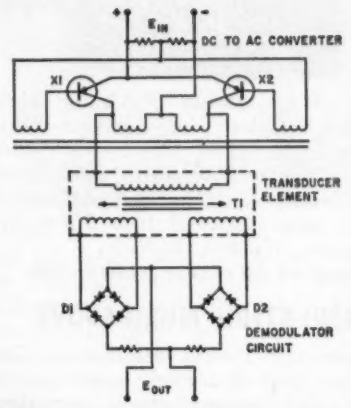
CIRCLE 81 ON READER-SERVICE CARD

DISPLACEMENT TRANSDUCERS
with **BUILT-IN SOLID STATE** *circuitry*

To permit dynamic measurements with micro-inch resolution



SPECIFICATIONS
Excitation: to 24 VDC
Range: ±.050" to ±50"
Scale Factor: to 100 V/in. DC
Linearity: 0.5 %
Dynamic Response: exceeds 1000 CPS
Resolution: infinite
Stability: 0.1 % F.S.
Temperature: to +275°F
SEND FOR DATA



G. L. COLLINS GLC CORPORATION
2820 EAST HULLETT STREET LONG BEACH 5 CALIFORNIA

CIRCLE 82 ON READER-SERVICE CARD

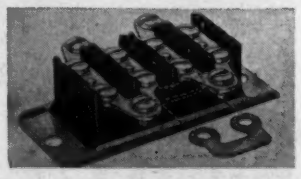
HI-TEMP LO-LOSS COAX CABLE

New high frequency low-loss coaxial cable Model 323, said to be capable of operation to 1500°F, is available with type C, N, TNC or BNC connectors for operation to 500°F or with special high temperature connectors to 1000°F. Sheath is 0.170" OD of copper or stainless steel, characteristic impedance os 50 ± 2 ohms, attenuation is 5 db 100' @ 400 mc to 12 db/ 100' @ 1500 mc. Velocity of propagation is 79.6% and VSWR is less than 1.05—*Instrument Div., Thomas A. Edison Industries,* 61

CIRCLE 304 ON READER-SERVICE CARD

JUNCTION BLOCK

New "J" Type junction blocks using terminal bar with six 6-32 screws can be jumpered together in

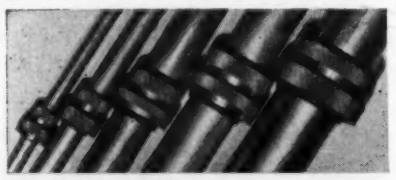


up to 12 single-pole groups giving a total of 71 taps from one feed-in. —*Curtis Development & Mfg. Co.,* 3250 *N. 33rd St., Milwaukee* 16, *Wisc.*

CIRCLE 305 ON READER-SERVICE CARD

FUEL TUBING COUPLINGS

New flexible couplings attach without flare or beads to metal tubing used in missile and aircraft fuel sys-



tems. They cover pressures up to and over burst value of tube, with ¼" axial motion and up to 8° angular flexibility. Available in ⅜" to 5" sizes for temperatures from −70° to 450°F.—*Gamah Corp.,* 1654 *Lincoln, Blvd., Santa Monica, Calif.*

CIRCLE 306 ON READER-SERVICE CARD

NAVAL ELECTRIC CABLES

New military-type Turbo 2843 cables for use aboard naval vessels, for any weapons and missile systems are available in a Class-E dielectric in type MSCA-10 cable for equipping, refitting and repair. In types SSGA, TSGA, DSGA and FSGA, sizes 9 and smaller are available.—*William Brand-Rex Division, American Enka Corp., Williamantic, Conn.*

CIRCLE 307 ON READER-SERVICE CARD

A. C. Potentiometer Simplifies Servo Design

Multiplication and Division. The Vernistat is fundamentally a multiplying element; multiplying input voltage by some function of shaft position (Fig. 1) i.e.

$$e_o = e_j \cdot f(\theta)$$

Even division may he handled in a limited manner: e.g.

$$e_o = e_j \cdot \frac{k}{\theta}$$

A nonlinear Vernistat whose output is the reciprocal of shaft angle may be used in this fashion for division.

Computer Element. The Vernistat's ability to handle computer applications is illustrated by Fig. 2. Conventional potentiometers may be used to solve such problems with satisfactory accuracy; however, the high impedances require an isolation amplifier for the multiplying function and addition is accomplished by

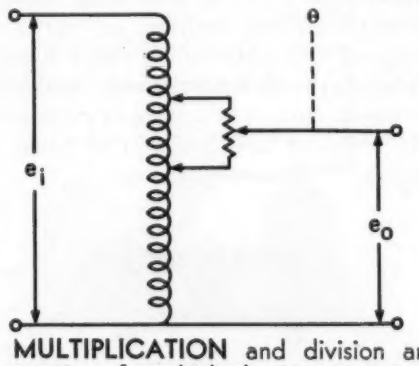


FIG. 1. **MULTIPLICATION** and division are basic analog operations for which the Vernistat is uniquely adapted.

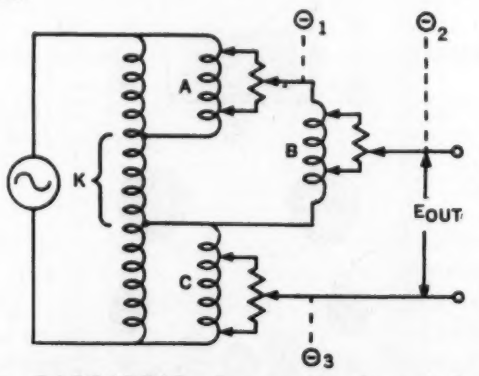


FIG. 2. **CASCADING** of computer elements is facilitated by high input, low output impedance ratio of the Vernistat. Output function is typical of multivariable computations which are possible.

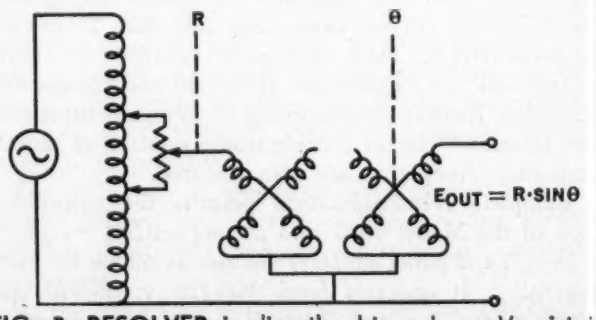


FIG. 3. **RESOLVER** is directly driven by a Vernistat to achieve accurate computation without an isolation transformer.

means of summing resistors and a feed back amplifier.

In the Vernistat circuit, multiplication may be accomplished directly, due to its high input, low output impedance ratio. By cascading units, it is possible to eliminate isolation amplifiers. Addition may be accomplished by utilizing phase reversal in the input transformer without using summing resistors and their amplifier.

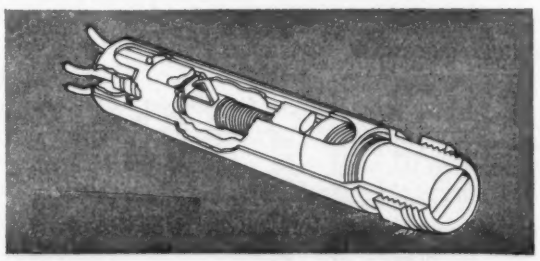
Resolver Driven by a Vernistat. A frequently recurring computation in navigation and fire-control systems is the multiplication of a linear variable by the sine of some angle, R sin θ. The natural choice of components is a potentiometer and a resolver. To achieve accurate computation without an isolation amplifier, a Vernistat may be used to drive a resolver directly (Fig. 3). This application takes advantage of the Vernistat's low output impedance which allows accuracy to be maintained under load.—(*From new 14-page Vernistat Catalog and Design Guide, Vernistat Division, Perkin-Elmer Corp., Norwalk, Conn.*)

FOR THIS LITERATURE CIRCLE 308 ON READER-SERVICE CARD

New Miniaturized Trimming Pots

A one-piece anodized aluminum case only ¼" in diameter and 1-7/16" long accommodates a new subminiature carbon trimming potentiometer available in seven standard values from 20K to 1 megohm, with ¼ watt capacity at 50°C derating to zero at 105°C.

High resistance to shock, vibration and acceleration is provided by the new "outside-in" construction principle (See Figure) in which the wiper-brush assembly is guided on a precise course in the grooved hollow mandrel providing continuous wiping action under extreme environmental conditions.



"OUTSIDE-IN" construction of new subminiature trimming potentiometer gives high resistance to environmental conditions.

Military specifications for environmental conditions, including vibration 30G, 80 to 4000 cps; shock at 100G; humidity seal; immersion seal; salt spray and sand and dust are met or exceeded. A potential of 200 v dc between element and case can be applied at an altitude of 90,000 ft.; also it is rated for a load life of 1,000 hours following a programmed cycle of 1½ hours on ½ hour off in accordance with the requirements of MIL-R-94A. Both 3-lead and 2-lead models are available. (*From 2-page specifications sheet, Series 026, one of five new specifications bulletins on Miniature Variable Resistors and Trimming Potentiometers, Con-Elco, 1711 South Mountain Ave., Monrovia, Calif.*)

FOR THIS LITERATURE CIRCLE 309 ON READER-SERVICE CARD

MSD new literature

CARRIER AMPLIFIER, Type 1-127 System comprising 4-channel amplifier, bridge balancing circuits, power supply, calibrating and control circuits, and 20-KC oscillator amplifies transducer signals for operation of Consolidated galvanometer or oscillographs. Described in new 2-page bulletin 1127.—Consolidated Electrodynamics Corp., 370 Sierra Madre Villa, Pasadena, Calif.

CIRCLE 310 ON READER-SERVICE CARD

WWV RECEIVER, TRANSISTORIZED, for calibration of field research gear and remote location work are described in new 4-page bulletin #360.—Specific Products, 21051 Costanso St., Woodland Hills, Calif.

CIRCLE 311 ON READER-SERVICE CARD

MISSILE CHECKOUT by new automatic electronic system, usable in depot, factory, field and launch site for the most sophisticated weapons system is described in set of 12 new tech data sheets.—Technical Products Div., Packard-Bell Electronics, 12333 W. Olympic Blvd., Los Angeles 64, Calif.

CIRCLE 312 ON READER-SERVICE CARD

COOLING EFFECT DETECTOR which monitors the cooling effect of the air or other media used to protect electronic equipment from excessive temperature is described with sensitivity and characteristic curves in new 4-page bulletin No. 688.—Vap-Air Div., Vapor Heating Corp., 80 E. Jackson Blvd., Chicago 4, Ill.

CIRCLE 313 ON READER-SERVICE CARD

SERVO REPEATER containing resolver, servo motor, servo amplifier, transformer, shaft position encoder and gear trains is described in new 2-page bulletin DPS/A6.—Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.

CIRCLE 314 ON READER-SERVICE CARD

BEACON INTERFERENCE Eliminator designed to remove spurious signals (fruit) from radar displays is described in 2-page bulletin MS101.—Stavid Div., Lockheed Electronics Co., Plainfield, N. J.

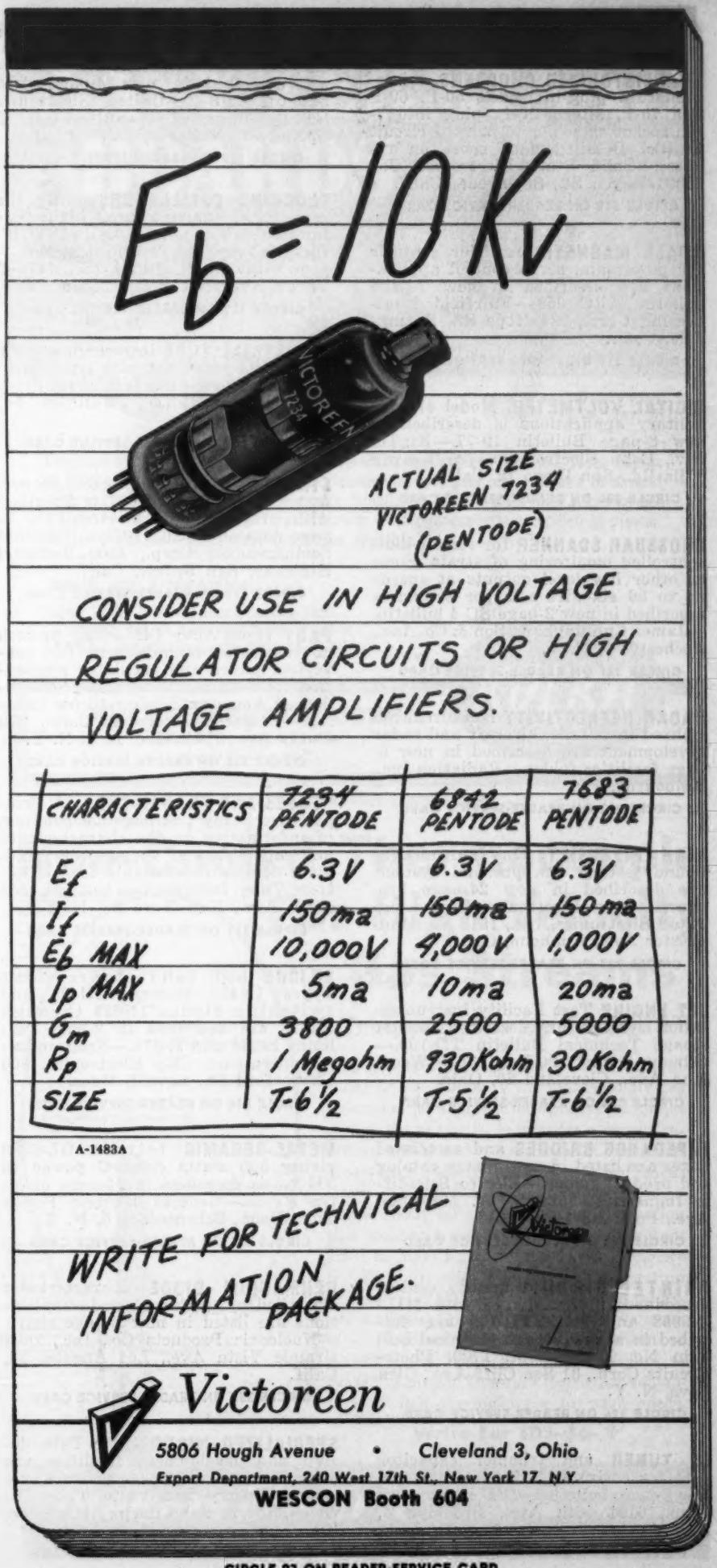
CIRCLE 315 ON READER-SERVICE CARD

SEVENTEEN LOGIC packages in new DEC 500 kc system plug-in building blocks are described in new 6-page folder.—Digital Equipment Corp., Maynard, Mass.

CIRCLE 316 ON READER-SERVICE CARD

SERVOMOTOR gearheads & speed reducers for 400 cps, offered in over 1000 ratios—from 5:1 to 78125:1 are described in new data sheet.—Guidance Controls Corp., 110 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE 317 ON READER-SERVICE CARD


Eb = 10Kv
VICTOREEN 7234
ACTUAL SIZE VICTOREEN 7234 (PENTODE)
CONSIDER USE IN HIGH VOLTAGE REGULATOR CIRCUITS OR HIGH VOLTAGE AMPLIFIERS.
CHARACTERISTICS | 7234 PENTODE | 6842 PENTODE | 7683 PENTODE
Ef | 6.3V | 6.3V | 6.3V
If | 150ma | 150ma | 150ma
Eb MAX | 10,000V | 4,000V | 1,000V
Ip MAX | 5ma | 10ma | 20ma
Gm | 3800 | 2500 | 5000
Rp | 1 Megohm | 930Kohm | 30Kohm
SIZE | T-6½ | T-5½ | T-6½
A-1483A
WRITE FOR TECHNICAL INFORMATION PACKAGE.
Victoreen
5806 Hough Avenue • Cleveland 3, Ohio
Export Department, 240 West 17th St., New York 17, N.Y.
WESCON Booth 604

CIRCLE 83 ON READER-SERVICE CARD

NEW LITERATURE—cont.

TRANSISTORIZED CHOPPERS, microminiature plug-in models 50-P, 60-P and 70-P, alternatively plug into 7-pin socket or solder to printed circuit boards. Detailed data sheet on request.—Solid State Electronics Co., 15321 Rayen St., Sepulveda, Calif.

CIRCLE 318 ON READER-SERVICE CARD

SMALL MAGNETIC rectifier controls for power and servo control applications are described in new 7-page bulletin MRC 658.—Fairfield Engineering Corp., 934 Hope St., Springdale, Conn.

CIRCLE 319 ON READER-SERVICE CARD

DIGITAL VOLTMETER, Model 412 for military applications is described in new 8-page Bulletin 19-77.—KinTel Div., Cohu Electronics, 5725 Kearny Villa Rd., San Diego 12, Calif.

CIRCLE 320 ON READER-SERVICE CARD

CROSSBAR SCANNER for remote dial-controlled monitoring of strain gages or other low level outputs at speeds up to 50 six-wire sets per second is described in new 2-page SC-4 bulletin. —James Cunningham, Son & Co., Inc., Rochester 8, N. Y.

CIRCLE 321 ON READER-SERVICE CARD

RADAR REFLECTIVITY measurements utilized in missile, aircraft and radar development are described in new 6-page facilities folder.—Radiation Inc., Melbourne, Fla.

CIRCLE 322 ON READER-SERVICE CARD

HIGH INTENSITY Environmental Sound testing concepts and systems are described in new 24-page brochure.—Ling Electronics Div., Ling-Altec Electronics, Inc., 1515 So. Manchester Ave., Anaheim, Calif.

CIRCLE 323 ON READER-SERVICE CARD

JET ENGINE Test Facility instrumentation systems are described in new 9-page Technical Bulletin TD-100.—Gilmore Industries, Inc., 13015 Woodland Ave., Cleveland 20, Ohio.

CIRCLE 324 ON READER-SERVICE CARD

IMPEDANCE BRIDGES and associated boxes are listed in new 5-page catalog and product folder.—Electro Scientific Industries, 7524 S. W. Macadam Ave., Portland 19, Ore.

CIRCLE 325 ON READER-SERVICE CARD

PRINTED CIRCUIT quality control procedures in accordance with MIL-Q-9858 and MIL-STD-105 are described in a new 4-page technical bulletin No. P-10.—Dept. 1700, Photocircuits Corp., 31 Sea Cliff Ave., Glen Cove, N. Y.

CIRCLE 326 ON READER-SERVICE CARD

LC TUNER and trimmer capacitor data for entire JFD line are listed in new 2-page bulletin.—JFD Electronics Corp., 6101 16th Ave., Brooklyn 4, N. Y.

CIRCLE 327 ON READER-SERVICE CARD

HIGH VACUUM Miniaturized Power Diodes with external anodes for missile and other airborne applications are described in new 4-page data bulletin CDB-1.—United Electronics Co., Subsidiary of Ling-Altec, Inc., 42 Spring St., Newark, N. J.

CIRCLE 328 ON READER-SERVICE CARD

BLOCKING OSCILLATORS using the new RCA subminiature, high performance, low power "NUVISTOR" vacuum tubes are described in new 4-page catalog.—Mini-Rad, Inc., 7416-E Varna Ave., No. Hollywood, Calif.

CIRCLE 329 ON READER-SERVICE CARD

INDUSTRIAL TUBE intrechangeability guide lists some 900 tube types in 8-page brochure.—Distributor Prod. Div., Raytheon Co., Waltham 54, Mass.

CIRCLE 330 ON READER-SERVICE CARD

SILICON DIODE, high-conductance, fast-recovery type FD200, is described with graphs and test circuit in 2-page data sheet SL 110/1.—Fairchild Semiconductor Corp., 4300 Redwood Highway, San Rafael, Calif.

CIRCLE 331 ON READER-SERVICE CARD

PADT (Post Alloy Diffusion) process of transistor manufacture for converton, mixer and oscillator applications is described in new 12-page condenced Amperex Semiconductor Catalog.—Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.

CIRCLE 332 ON READER-SERVICE CARD

"TUBES AND TRANSISTORS: A Comparative Study", 64-page compendium of information on the characteristics and capabilities of vacuum and solid-state devices is available from Electron Tube Information Council, 554 Fifth Ave., New York 36, N. Y.

CIRCLE 333 ON READER-SERVICE CARD

SILICON high conductance diodes Types 1N482 through 1N485 and switching diodes 1N625 through 1N629 are described in 2-page bulletins E-373 and E-374.—Semiconductor operations, CBS Electronics, 900 Chelmsford St., Lowell, Mass.

CIRCLE 334 ON READER-SERVICE CARD

METAL-CERAMIC tetrode GL-6283 giving 300 watts class C power to 900 mc is described in 24-page bulletin PT-35.—General Electric Power Tube Dept., Schenectady 5, N. Y.

CIRCLE 335 ON READER-SERVICE CARD

GERMANIUM DIODE characteristics classified by preferred diode applications are listed in new 2-page chart. —Nucleonic Products Co., Inc., 1601 Grande Vista Ave., Los Angeles 23, Calif.

CIRCLE 336 ON READER-SERVICE CARD

SPECIALIZED MICROWAVE Tube design and development facilities are described in new-16-page product brochure.—Sperry Electronic Tube Division, Sperry Rand Corp., Gainesville, Fla.

CIRCLE 337 ON READER-SERVICE CARD

TIME DELAYS, Types 401 and 404 general purpose Units ranging from 0.1 to 300 seconds are described in 4-page bulletin No. 80.—G-V Controls Inc., 101 Okner Parkway, Livingston, N. J.

CIRCLE 338 ON READER-SERVICE CARD

MILITARY TYPE Resistors, rheostats, and tantalum capacitors, including fixed resistors for superseded specifications, are provided with complete physical and electrical specs in new 32-page catalog No. 50.—Ohmite Manufacturing Co., 3601 Howard St., Skokie, Ill.

CIRCLE 339 ON READER-SERVICE CARD

COAXIAL RATIO TRANSFORMERS for precise ac voltage division are described in new 4-page technical data brochure, Models CRT-1 through 6.—Gertsch Products, Inc., 3211 So. La Cienega Blvd., Los Angeles 16, Calif.

CIRCLE 340 ON READER-SERVICE CARD

MINI PULSE TRANSFORMERS, mfgrs complete line is described in a new 4-page Bulletin PT-210.—Technitrol Engineering Co., 1952 East Allengheny Ave., Philadelphia 34, Pa.

CIRCLE 341 ON READER-SERVICE CARD

REGULATED POWER Supplies used in TIROS Satellite Ground Support system are described in 6-page bulletin.—Lambda Electronics Corp., 11-11 131 St., College Point 56, N. Y.

CIRCLE 342 ON READER-SERVICE CARD

SUB-MINIATURE SWITCH, said to be the smallest and lightest environment-free switch available is described in new 2-page data sheet.—Micro Switch Div., Minneapolis-Honeywell Reg. Co., 11 W. Spring St., Freeport, Ill.

CIRCLE 343 ON READER-SERVICE CARD

SUBMIN DELAY LINES with component densities up to 150 sections per cubic inch are described in new 2-page data sheet.—Valor Instruments, Inc., 13214 Crenshaw Blvd., Gardena, Calif.

CIRCLE 344 ON READER-SERVICE CARD

"LOW TEMPERATURE Technology—What's the Latest?" is the title of a timely six-page brochure on this subject.—Arthur D. Little, Inc., 38 Acorn Park, Cambridge 40, Mass.

CIRCLE 345 ON READER-SERVICE CARD

LEAD SULFIDE Photoconductors are described with typical Infratron detector performance graphs in new 4-page bulletin No. 7. Also includes "how-to-order" directions.—Infrared Industries, Inc., P. O. Box 42, Waltham 54, Mass.

CIRCLE 346 ON READER-SERVICE CARD

QUARTZ CRYSTAL transducers for pressure, force, acceleration and vibration measurements are described in new 4-page bulletin 101160.—Kistler Instrument Corp., 15 Webster St., No. Tonawanda, N. Y.

CIRCLE 347 ON READER-SERVICE CARD

The Partial-Flux Word-Select Core Memory Technique

The partial-flux word-select core memory system offers the advantage of faster cycle times for a given size core than is possible with the coincident-current system. The most significant limiting factor in the cycle time for coincident-current core memories is the overheating of the core resulting from the large amount of flux switched on each cycle. Using the word-select technique, only a small percentage of the total flux available in the core is required for core operation. Less energy is dissipated in each cycle and, consequently, the core can be switched more times per second. The relative amounts of flux switched for comparable cores by the word-select and coincident-current techniques are shown in Fig. 1. Areas enclosed within the curves are proportional to the energy dissipated in one cycle.

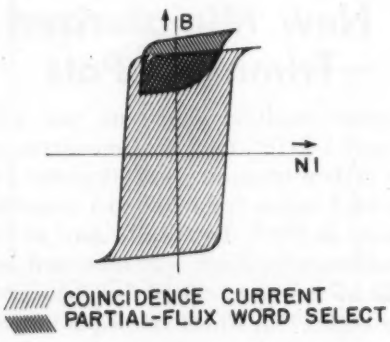


FIG. 1

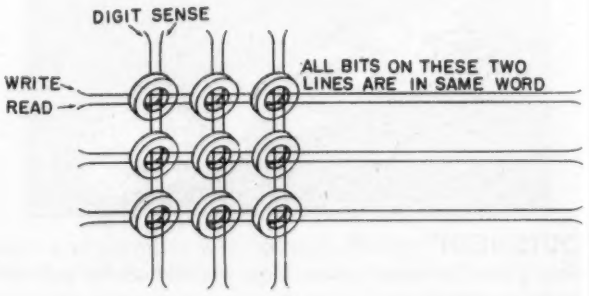


FIG. 2

During the read-write cycle of the memory, the cores in a word-select array are only partially switched. All the bits for a given word are on the same read and write lines and usually on the same array. Each bit has a separate sense winding which crosses the array perpendicularly to the word (see Fig. 2 for array configuration). To read a word, a current I_R enough to put the core on the major loop, energizes the write line through the selected word. The bit associated with each digit in the word is read on its sense winding. A read pulse puts all cores in the word at point A on the word-select hysteresis curve shown in Fig. 1. Because the

pulse appears only on the line through the selected word, other cores on the array are not disturbed. Provision for cancelling partial disturbances (required when the coincident-current method is used) is unnecessary and array wiring is simplified.

To write a word, a write pulse I_w energizes the write line through the word in the direction opposite to the read pulse. Since this pulse is not large enough to move the core from the ZERO position on the major loop, the core remains in the ZERO state. To write a ONE, a digit pulse I_d is applied to the digit winding for the applicable bits. The values of I_d and I_w are such that the core is not switched except where the pulses are additive through the core. Amplitude and width of I_d and I_w are controlled so that a core in the ONE position will be put on a minor loop. Although the digit pulse disturbs all other cores in the digit plane, cores in the ZERO position, being on a major loop, are not seriously disturbed. Cores in the ONE state are merely driven farther into that state by the digit pulse. The flux accrued by a disturbed ONE core is less than 5% greater than that accrued by an undisturbed ONE.

Control of the amplitude and width of the write and digit currents is not critical because there are many minor loops on which the core can settle in the ONE state and still function satisfactorily. The signal-to-noise ratio of a system operated in the word-select mode is comparable to that of a coincident-current system.

The smaller area enclosed within the curve (flux switched for a word-select core Fig. 1), indicates less heating which, in turn, enables faster operation of the core and lowers drive requirements—the principal advantages of this type of core and mode of operation.

The principal disadvantage of a core memory operated by the word-select method is that most access drivers are required than for a core memory operated by the coincident-current method. While this increases the fabrication cost per bit, the operation cost per bit per second is reduced, effecting a more economical memory operation.—(*From 4-page bulletin of same title, by Components Div., Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.*)

FOR THIS LITERATURE CIRCLE 348 ON READER-SERVICE CARD

BOOK REVIEWS

RCA RECEIVING TUBE MANUAL, RC-20, (1960), Electron Tube Division, Radio Corporation of America, Harrison, N. J., 432 p., 8 ¼″ x 5 ⅜″, $1.00. Data for more than 760 receiving tubes, including types for B&W and color TV, 12-v car radio receivers and Hi-Fi Audio applications. Stereo amplifiers, receivers, and Hi-Fi subcircuits are among the 24 circuits featured.

FOR MORE INFORMATION CIRCLE 349 ON READER-SERVICE CARD

THEORY OF INERTIAL GUIDANCE, by Connie L. McClure, (1960) Prentice-Hall, Inc., 70 Fifth Ave., NewYork 11, N. Y., 350 p., 6″ x 9″, $12.00, Classical dynamics is combined with modern concepts and latest developments in an integrated treatment of the analytical and mechanical principles of inertial guidance systems.

FOR MORE INFORMATION CIRCLE 350 ON READER-SERVICE CARD

MINI INFRARED source Model PE 521-6 for calibrating the seeking head of infrared guided missiles and other sensitive elements in the 200° to 600°C range is described in 2-page data sheet.—Electro-Optical Div., Perkin-Elmer Corp., Norwalk, Conn.

CIRCLE 351 ON READER-SERVICE CARD

BERYLLIUM TUBING properties related to uses in nuclear, aircraft and missile construction are set forth in new data memo No. 26 (4-pages).—Superior Tube Co., 1564 Germantown Ave., Norristown, Pa.

CIRCLE 352 ON READER-SERVICE CARD

THERMOSETTING laminated materials 4-page engineering data chart shows the principal grades and properties of each type.—Comco Plastics, Inc., 98-34 Jamaica Ave., Richmond Hill 18, N. Y.

CIRCLE 353 ON READER-SERVICE CARD

EPOXY PACKAGING for electronic components using E-Form pellets is explained in new 4-page bulletin No. 3.—Epoxy Products, 137 Coit St., Irvington, N. J.

CIRCLE 354 ON READER-SERVICE CARD

MAGNESIUM ALLOYS' advantages to designer and fabricators of electronic components are described in a new 20-page brochure.—The Dow Metal Products Co., Midland, Mich.

CIRCLE 355 ON READER-SERVICE CARD

METAL CLOSURES from transistor caps to transformer housings are described in new 6-page facilities brochure.—Hudson Tool & Die Co., 18-38 Malvern St., Newark 5, N. J.

CIRCLE 356 ON READER-SERVICE CARD

MAGNETIC SHIELDING of Transformers and Tubes is described with precise design and performance efficiency data in new 16-page revised Bulletin F-1.—Magnetic Metals Co., Hayes Ave. at 21st St., Camden 1, N. J.

CIRCLE 357 ON READER-SERVICE CARD

SEMIRIGID METAL shielded cable with greater strength, less attenuation than corresponding RG/U cables are described in new 2-page data sheet.—Dept. C-2, Precision Tube Co., Inc., North Wales, Pa.

CIRCLE 358 ON READER-SERVICE CARD

TEFLON-INSULATED hook-up wire for internal wiring of meters, panels, electrical and electronic equipment, and RF data on Teflon cable for radar and communications systems are given in 4-page brochure, DM-S-6001.—Sequoia Wire & Cable Co., 2201 Bay Rd., Redwood City, Calif.

CIRCLE 359 ON READER-SERVICE CARD

ELECTRONIC CERAMICS research activity by Lockheed Electronics described in new 8-page facilities brochure mentions rectangular and square hysteresis loop ferrites, multiaperture devices, and ultra-thin-walled toroids.—Lockheed Electronics Co., 6201 East Randolph St., Los Angeles 22, Calif.

CIRCLE 360 ON READER-SERVICE CARD

NAVY TERMINAL BOARDS

Made to Navy drawing 9000, S6505 B, 73214, Rev. H.

Designed by the Bureau of Ships and covered by applicable MIL specs, these boards or blocks are ideal for other heavy-duty assemblies and services. Available in several different lengths and number of terminals. Supplied in MAI-60 glass-filled Alkyd as per MIL-M-14 with latest revision. Threaded studs of manganese-bronze, molded in plastic. Slotted brass nuts. Other Navy types also available.

WRITE FOR LITERATURE . . .

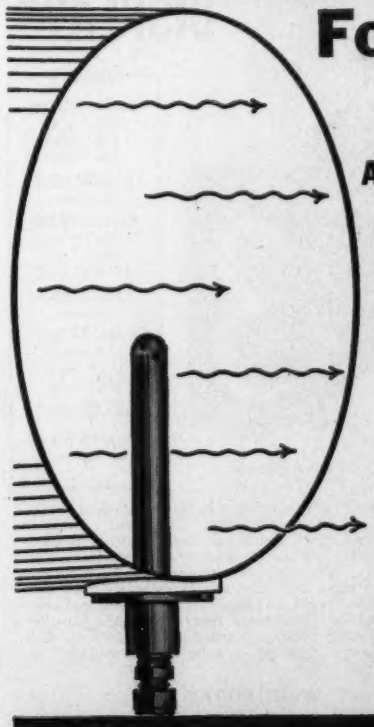
Latest Kulka Terminal Block Catalog sent on request. Let us have your terminal block problems and requirements. Our specialty!

KULKA

KULKA ELECTRIC CORP.
633-643 So. Fulton Avenue
Mount Vernon, N.Y.

CIRCLE 84 ON READER-SERVICE CARD

Non-Cooled Thermocouple For High Velocity Gas Streams



At Temperatures Up To 3600°F.

This new thermocouple can be used without water or air cooling in the high velocity gas streams of jet engine afterburners and ramjet and rocket exhausts. It includes a cermet radiation shield and support tube. Conduction errors from cooling are eliminated and installation is simplified. Radiation losses are reduced about 60%. In a typical application this probe endured temperature cycling from 1500 to 3000°F. at a 1500 ft./sec. velocity for 20 hours with no failure. Temperature changes of 2000°F./sec. have created no adverse effects. Conductors used are Platinum 30% Rhodium/Platinum 6% Rhodium to 3000°F., and Iridium Rhodium/Iridium to 3600°F. Contact Thermo Electric for adaptation of this thermocouple to your needs.

Write For EDS-36-9

Thermo Electric CO., INC.
SADDLE BROOK, NEW JERSEY

In Canada:
THERMO ELECTRIC (Canada) LTD.
Brampton, Ont.

CIRCLE 85 ON READER-SERVICE CARD

NEW
TRANSFER FUNCTION ANALYZERS
Type 308A & 308B
Direct reading of both in-phase and quadrature components without adjustment or computation.
Automatic and continuous plotting of nyquist diagram when used in conjunction with X-Y recorder.
Applicable for both d.c. (servo frequency) or a.c. (modulated carrier) signals in servo systems without external demodulator.
AD-YU
Formerly Advance
ELECTRONICS LAB, Inc.
249 TERHUNE AVENUE
PASSAIC, NEW JERSEY
CAPACITOR TESTER
Type A101
Measures loss factor angle directly in degrees when used in conjunction with Ad-Yu Type 405 Precision Phase Meter.
Measures unknown capacitors directly in microfarads.
Simple to operate, suitable for production use.
Less than 0.5 volt a.c. and 1.5 volt d.c. voltages across capacitor under test.
Accuracy better than 3%.
Specializing
IN
PHASE METERS
DELAY LINES
ULTRA-FAST RISE TIME DELAY LINES
Type 10T & 11T
Rise time can be 1% or 2% of the total time delay.
Attentuation less than 1 db. Accuracy 2%.
Impedance 50 ohms to several thousand ohms.
Total delay from 0.5 us to over 500 us.
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COAXIAL TERMINATIONS, and attenuators for 1 to 5 watts, over dc to 12 kmc range are described in two 4-page bulletins.—R L C Electronics, Inc., 805 Mamaroneck Ave., Mamaroneck, N. Y.

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GLASS INDUCTOR characteristics covering 0.05 to 2.0 μh range are given in Data Sheet CE-5.00.—Corning Electronic Components, Corning Glass Works, Bradford, Pa.

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POROUS ANODE Tantalytic® Capacitor specifications covering 6 to 60 v dc operation at 85°C over a range of 5 to 3000 volt-microfarads are listed in new 4-page Bulletin GEA-7008A.—Capacitor Dept., General Electric Co., Irmo, S. C.

CIRCLE 363 ON READER-SERVICE CARD

CERAMIC capacitors in Axial, Axial Radial and new VK micro miniature series are listed in new 4-page brochure.—Schweber Electronics, 60 Hericks Rd., Mineola, L. I., N. Y.

CIRCLE 364 ON READER-SERVICE CARD

RG/U COAXIAL cable types are listed with electrical and physical engineering data in new 16-page catalog CC859.—Times Wire & Cable Co., Wallingford, Conn.

CIRCLE 365 ON READER-SERVICE CARD

WAVEGUIDE FLANGE Seals Conversion chart (20" x 20"), showing all wave band series and Parker's Seals to fit standard flanges, also folds to fit catalog or file.—Parker Seal Co., 10567 Jefferson Blvd., Culver City, Calif.

CIRCLE 366 ON READER-SERVICE CARD

INSULATORS, test points, sockets and other electronic products of Telfon, Nylon, Kel-F, Delrin and other plastics are listed in new 24-page catalog.—Garlock Electronic Products, The Garlock Packing Co., Camden 1, N. J.

CIRCLE 367 ON READER-SERVICE CARD

PLUGS, JACKS, connectors, adaptors and switches are illustrated with specs in 32-page catalog FR-61-E.—G. C. Electronics Div., Textron Electronics, Inc., 400 So. Wyman St., Rockford, Ill.

CIRCLE 368 ON READER-SERVICE CARD

CIRCUIT BREAKER Specification, AM 513 (4-page) illustrates standard current ratings, release coil impedances, time delay curves, and outline dimensions.—Airpax Electronics Inc., Cambridge, Md.

CIRCLE 369 ON READER-SERVICE CARD

SLIP RING assemblies in 7 standard types are described in a 28-page catalog.—Breeze Corp., Inc., 700 Liberty Ave., Union, N. J.

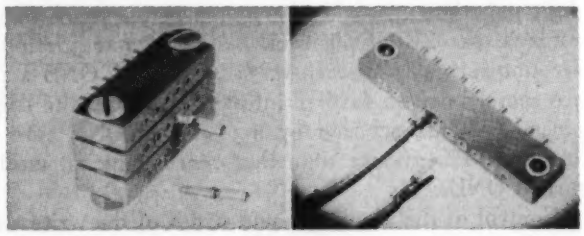
CIRCLE 370 ON READER-SERVICE CARD

MINIATURE BALL BEARINGS are listed in 4-page short form catalog 2-E-1, which also lists RMB types interchangeable with other leading manufacturer's bearing types.—Landis & Gyr, Inc., 45 West 45th St., New York 36, N. Y.

CIRCLE 371 ON READER-SERVICE CARD

Taper-Pin Terminals for Printed Circuits

Mounting and wiring convenience characterizes the miniaturized Taper-Pin Terminal Blocks in Type 399-6 (six terminal) and Type 399-10 (ten terminal) sizes. Such blocks may be mounted (a) upright on printed-circuit boards with solder studs slipped through holes for dip soldering on reverse side; (b) flat-mounted on board, chassis or casing, with connections front and rear; and (c) stack-mounted for a plurality of units. Permanently soldered connections are made to the terminal studs on one side, and taper-pin (solderless) connections to taper-pin receptacles on the other (see Figure).



While primarily intended for printed-circuit applications, these miniaturized terminal blocks are also recommended for computer and other intricate assemblies, with two or more blocks stacked, where space is at a minimum and maximum wiring must be accommodated. (*From 36-page catalog No. 16, "Terminal Blocks, Switches and Accessories," Kulka Electric Corp., 633-643 So. Fulton Ave., Mt. Vernon, N. Y.*)

FOR THIS LITERATURE CIRCLE 372 ON READER-SERVICE CARD

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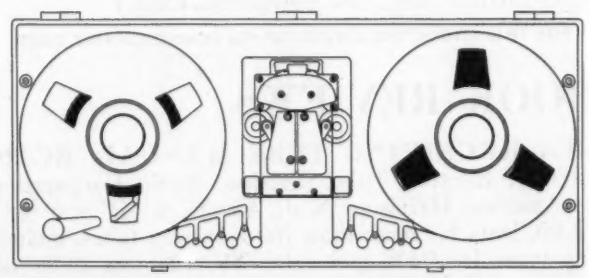

TAPE DECK Model DT Recorder/Reproducer Unit.

Available in DT 01 (write only), DT 02 (read only) and DT 03 (read and write) conformations, all models accommodate up to 14 amplifiers, read or write in any combination, inside the transport housing. Transistorized, modular construction of plug-in electronics facilitate simple maintenance of already high reliability circuitry. (*From 4-page brochure giving all technical data, DT Series, Shepherd Industries, Inc., Nutley, N. J.*)

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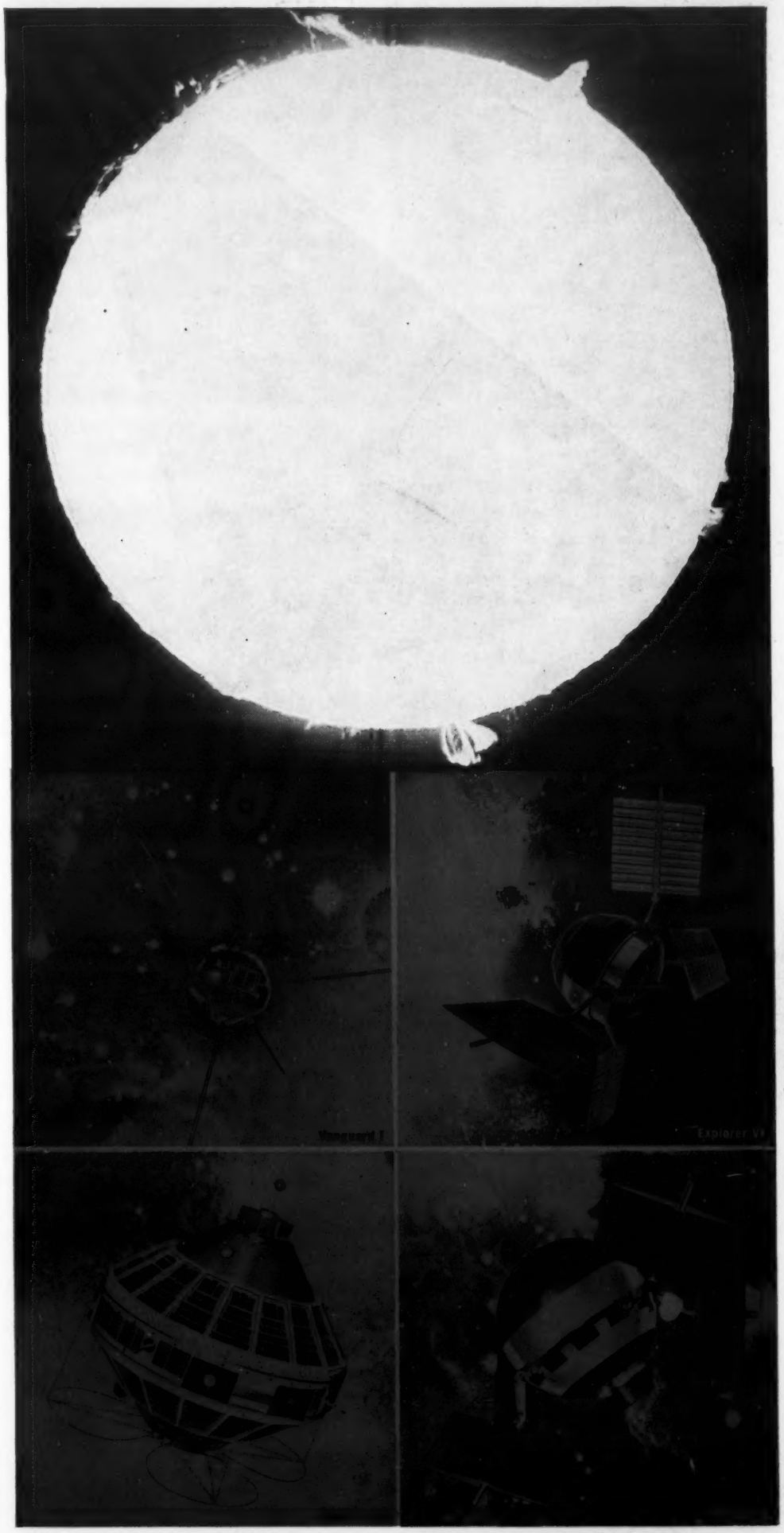

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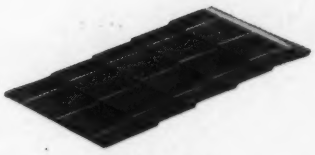

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